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ANALYSIS OF PREDATOR-PREY BALANCE IN BANDIPUR TIGER RESERVE WITH REFERENCE TO CENSUS REPORTS[1]

K. ULLAS KARANTH[2]

The deciduous forest habitats of the 690 km² Bandipur tiger reserve in Karnataka State harbour major mammalian predators such as tiger, leopard and dhole supported by a large and diverse assemblage of prey species. It is reported that populations of these animals have increased dramatically in recent years, in response to improved management practices. These conclusions are drawn on the basis of population estimates of different species obtained using several census techniques currently in practice. In this paper I have examined the broad predator-prey balance among larger mammals of the reserve using the 1982 census figures, integrating ecological data on these species from several recent studies into the analysis.

This analysis suggests that the predator and prey population estimates are not meaningful. Comparisons of distributional density and biomass of different species and the total prey biomass calculated here with those obtained from other important studies in the Indian sub-continent reinforce these conclusions. Therefore, a radical revision of all the present census techniques and introduction of appropriate modern census methods are recommended.

INTRODUCTION

The deciduous forests of the 690 km² Bandipur tiger reserve described by Neginhal (1974) harbour a diverse assemblage of large mammals (Table 1). Due to strict control over biotic interferences and systematic management under 'Project Tiger' since 1973, it is reported that populations of large mammals have increased substantially. This claim is supported by the annual census reports. Particularly notable is the reported increase of tiger population from 11 in 1973 to 54 in 1984 (Basappanavar 1985).

The census of tigers/leopards is made from pugmarks; elephant and gaur from 'visual counts' and other animals from 'sample counts'

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(Basappanavar 1985). During the October 1982 census, which I observed, the entire reserve was divided into 103 compartments (average 6.9 km^2) and between 0600-1600 hrs three member teams perambulated each compartment thoroughly, following no predetermined path. They collected 'plaster casts' of pugmarks and recorded animal sightings on a printed form. This field data was later consolidated to arrive at the census estimates (Table 2).

In this paper I have tried to analyse the predator-prey balance for the reserve based on these estimates. I have focussed my analysis on the larger carnivores, as they are sensitive indicators of habitat quality and may be studied at greater profit to gauge the health and extent of an environment to be preserved (Eisenberg 1980).

To simplify the analysis I have made the following assumptions:

(i) The large predators are cropping only the incremental prey biomass annually, without depleting the prey base.

(ii) Chital, sambar, muntjac, wild pig, gray langur and livestock form the major prey and accounted for 75% of the intake of tiger, leopard and dhole.

RELATIVE NUMBERS OF PREDATORS AND PREY

Prey requirements of predators

Studies by Schaller (1967), Sunquist (1981) and Tamang (1982) indicate that tigers on an average need about 3000 kg of prey every year. On this basis the 49 tigers estimated in the 1982-83 census have an annual prey requirement of 1,47,000 kg. Similarly, the annual prey requirement of the leopard appears to be about 1,000 kg (Schaller 1967, Muckenhirn and Eisenberg 1973). The requirement of 50 leopards reported would be 50,000 kg per year. Johnsingh (1983) estimated the annual prey requirement of an adult dhole at 680 kg. Being coursing predators, presumably they have a higher energy expenditure per unit body weight in comparison to the two felines which are stalking predators. Considering subadults and pups in the population which have lower requirements, it is reasonable to presume an average annual requirement of 340 kg of prey per dhole. On this basis, the estimated population of 152 dhole needs 51,680 kg of prey per year. Therefore the total annual prey intake of all the tigers, leopards and dholes estimated to exist in Bandipur reserve during 1982-83 works out to 2,48,680 kg.

During 1982-83, 131 cattle were reported to be killed by large predators in and around the reserve (Basappanavar 1985). Including unreported cases the maximum number of cattle killed can be assumed to be 200, since the villagers usually report any kill to claim compensation. At an average unit weight of 150 kg, these cattle met the prey requirement to the extent of 30,000 kg. Other minor wild prey species (Gaur, four-horned antelope, black-naped hare, bonnet monkey, peafowl etc.) consist of 25% of the total prey intake (as per assumption No. ii) and account for an additional 62,170 kg.

Therefore, the total weight of major wild prey species (chital, sambar, muntjac, wild pig and gray langur) consumed by large predators during the year was 1,56,510 kg (say 1,56,000 kg) based on census estimates of predators.

Availability of major wild prey species

In table 2, I have worked out the crude density and crude biomass of the major wild prey species using census data. From this it is seen that during 1982-83 Bandipur reserve had a standing biomass of 1,29,770 kg (say 1,30,000 kg) of major wild prey. What proportion of this biomass was cropped by predators?

TABLE 1

LARGE MAMMALS RECORDED IN BANDIPUR TIGER RESERVE*

Scientific Name	Common Name
PRIMATA	
Macaca radiata	Bonnet macaque
Presbytis entellus	Gray langur
Loris tardigradus	Slender loris
LAGOMORPHA	
Lepus nigricollis	Blacknaped hare
RODENTIA	
Hystrix indica	Indian porcupine
Ratufa indica	Indian giant squirrel
Petaurista petaurista	Large brown flying squirrel
CARNIVORA	
Panthera tigris	Tiger
Panthera pardus	Leopard
Felis chaus	Jungle cat
Felis bengalensis	Leopard cat
Viverricula indica	Small Indian civet
Paradoxurus hermaphroditus	Common palm civet
Lutra lutra	Common otter
Melursus ursinus	Sloth bear
Herpestes edwardsi	Common mongoose
Herpestes smithi	Ruddy mongoose
Herpestes vitticollis	Stripenecked mongoose
Canis aureus	Jackal
Cuon alpinus	Dhole
Hyaena hyaena	Striped hyena
PROBOSCIDEA	
Elephas maximus	Indian elephant
ARTIODCTYLA	
Bos gaurus	Gaur
Tetracerus quadricornis	Four horned antelope
Sus scrofa	Wild pig
Muntiacus muntjak	Muntjac
Cervus axis	Chital
Cervus unicolor	Sambar
Tragulus meminna	Chevrotain
PHOLIDOTA	
Manis crassicaudata	Indian pangolin

* From Neginhal (1974) and personal observations.

TABLE 2

DENSITIES AND BIOMASS OF SELECTED LARGE MAMMALS IN BANDIPUR TIGER RESERVE DERIVED FROM THE 1982-83 CENSUS ESTIMATES

Species	Census Estimates	Density Nos./km^2	Unit wt.* kg	Average Biomass Kg/km^2	Total Standing Biomass Kg
Wild Prey					
Gaur	551	0.79	545.0	435.21	300 295
Sambar	342	0.50	113.6	56.30	38 851
Chital	1333	1.93	45.0	86.93	59.985
Muntjac	92	0.13	13.4	1.78	1 233
Wild pig	772	1.12	25.8	28.86	19 917
Gray langur	1223	1.77	8.0	14.18	9 784
			Total:	623.26	430 065
Predators					
Tiger	49	0.0710	150.0	10.65	7 350
Leopard	50	0.0725	45.0	3.26	2 250
Dhole	152	0.2203	18.0	3.97	2 736
			Total:	17.88	12 336

* The average unit weight for the species is selected from: Schaller (1967) for Gaur, chital and wild pig; Seidensticker (1976) for sambar; Eisenberg & Lockhart (1972) for muntjac; Johnsingh (1983) for gray langur and dhole; and Eisenberg (1980) for tiger and leopard.

Schaller (1972) and Sunquist (1981) estimated that annually predators remove about 10% of the standing biomass. Johnsingh (1983) estimated it at 20% in his study area of 20 km^2 around Bandipur campus. However, he attributed this higher rate of removal to the additional predation caused by the sudden withdrawal of livestock from the area just prior to his study.

Thus a maximum annual cropping by predators of the order of 15% seems reasonable for this analysis. Therefore, the possible annual removal of biomass of major wild prey species by the large predators works out to 19,500 kg. However as seen earlier annual consumption of such prey amounts to 1,56,000 kg, based on census estimates of predators. The annual cropping by predators seems to exceed the standing biomass of major prey species !

These calculations indicate that the official census estimates of large predators are significant overestimates and those of major prey species are possibly underestimates.

Biomass of prey

Eisenberg and Seidensticker (1976) have synthesized the information on ungulate biomass and densities from several studies in South Asia. Johnsingh (1983) has assessed these for his 20 km^2 study area in Bandipur reserve, which is the best wildlife area in the entire reserve. Based on published data and census estimates I have presented the densities and biomass for the major prey species (Table 2).

The biomass figures calculated above can be compared to those from other studies cited above. Biomass figures of 383 kg/km^2 for Gir forest, 1708 kg/km² for Kanha reserve and 3,382 kg/km² for Johnsingh's 20 km² study area in Bandipur are available. In spite of lower incidence of livestock grazing pressure the calculated biomass of major prey species works out to only 623 kg/km² in comparison. From the above comparison, the estimated prey biomass and hence the census estimates on which they are based appear to be too low for Bandipur tiger reserve.

Densities and Biomass of Predators

Johnsingh (1983) who pioneered the study of dhole in Bandipur estimated that the mean number of dhole varied between 7-18 in his study area. This yields a density of 35 to 90 dhole/100 km². However, it must be noted that his study area had a high density of prey and ecologically almost ideal habitat conditions for dholes. The reserve as a whole is more densely forested and has a lower prey density. Therefore, the density of 22 dhole/100 km² obtained from census estimate appears rather high.

While high densities of 17-20 leopards/100 km² are reported from habitats in Sri Lanka (Eisenberg 1980, Santiapillai *et al.* 1982) where competing predators like tiger and dhole are entirely absent, the reported density of 7.25 leopards/100 km² in Bandipur needs to be cautiously viewed, in the absence of any corroborative evidence.

Studies of the tiger in Kanha by Schaller (1967), Panwar (1979a) show densities 3.1-4.7 animals/100 km². Intensive radio-tracking studies (Sunquist 1981, Tamang 1982, Sunquist and Mishra, *in press*) in Chitwan have yielded density estimates of 2.3-3.7 tigers/100 km². These study sites were notable for the virtual absence of dholes and carried substantially higher prey biomass in comparison with the post-1973 Bandipur reserve. Inspite of this, the census estimates yield an extraordinarily high density of 7.10 tigers/100 km² indicating a significant overestimate for this species.

The predator to prey biomass ratios calculated using census estimates works out to 1:35 for Bandipur reserve as against 1:250 for Serengeti, 1:100 for Ngorongoro, 1:123 for Chitwan, 1:75 for Wilpattu and 1:124 for Johnsingh's study area (Ratios calculated from Schaller 1972, Eisenberg 1980, Eisenberg and Seidensticker 1976 and Johnsingh 1983).

On the basis of the above analysis it can be concluded that:

(i) The census estimates for large predators in general and tigers in particular are significant overestimates.

(ii) The census estimates of prey species are not meaningful and might be underestimates.

(iii) Therefore, the census techniques currently used in Bandipur tiger reserve are basically wrong and need to be modified keeping in view recent trends and developments in wildlife management.

CENSUS METHODS

A Review of present Census Techniques

The census estimates of tigers/leopards are now obtained at Bandipur using the pugmark tracing technique developed by Choudhury and described by Panwar (1979b). Apart from not having been validated on a known population anywhere, the technique demands a great deal of personal skill on the part of the practitioner. In addition to this subjective bias the following errors might have led to the overestimates in Bandipur:

(i) Absence of continuous year-round recording of pugmarks and assigning home-ranges to individual resident animals as done by Panwar (1979a) and McDougal (1977). The once a year census of Bandipur does not enable identification of individual animals with their home ranges.

(ii) Classification of the pugmarks of a single animal as those of several animals due to the differences caused by substrate conditions.

(iii) Collection of pugmarks of different limbs and collection of pugmarks from distant localities made over a 2-3 day period.

The estimates for elephant and gaur are reported to be from 'visual counts' and of other species from 'Sample counts' (Basappanavar 1985). Both these estimates are likely to be wrong due to the following reasons:

(i) Due to the limited visibility the census teams fail to actually obtain a total count of gaur and elephants. However, since these animals range over considerable distances, often in response to the census activity itself, some of them are likely to be counted by two or more adjoining census parties. Therefore, these cannot be considered total counts.

(ii) Since the census teams do not follow a repeatable pre-determined transect and do not also maintain any record of the width/length of the forest strip being sampled, the counts of other species also cannot be accepted as sample counts.

In practice, however, the reserve managers seem to treat these arbitrary counts of all species as total counts (Basappanavar 1979, Wesley 1977) leading to estimates which are not meaningful.

Alternative Methods and Techniques

Before suggesting alternatives, the following points summarised from Caughley (1977) need consideration. The abundance of an animal species can be measured in three ways:

(i) Number of animals in a population (*census* or *total count*).

(ii) Number of animals per unit area (*absolute density*).

(iii) Density of one population relative to another — e.g., between different years or different locations (*relative density*).

Most ecological and management problems can be tackled with the help of suitable *indices of relative density* and many others with the help of *absolute density estimates. Total counts* have very few practical uses. I have outlined here, briefly, some alternate methods for estimating abundance of mammalian species at Bandipur keeping these points in view. Wherever possible, I have referred to some sources on the theory and practice of these alternate techniques:

(i) Relative density of tigers/leopards between localities or years can be estimated using suitably designed indices like number of tracks/scats/sightings per km of roads traversed (Joslin 1973).

(ii) Absolute density of tigers/leopards can be estimated using home-ranges determined through systematic, year-round pugmark collections (McDougal 1977, Panwar 1979b). Identification of specific individuals from facial markings/coat patterns from photos obtained with camera trap devices can *validate* these estimates (McDougal 1977).

(iii) For all the reasonably abundant large mammalian species good indices of relative density in stratified habitats can be derived from roadside counts from vehicles, counts at water holes/feeding spots (Caughley 1977, Overton 1971, Berwick 1974, Dinerstein 1980).

(iv) For smaller, shy or nocturnal species e.g., rodents, mongooses, civets, smaller felids indices of relative densities can be obtained using capture-mark-recapture techniques (Overton 1971, Begon 1979 and Anon. 1981).

(v) Indices of relative densities for a wide range of species, particularly ungulates, can be obtained from pellet group/scat counts from linear strips or quadrats (Overton 1971, Mishra 1982).

(vi) For a large number of reasonably abundant diurnal mammals absolute densities can be estimated in stratified habitats using line transect censuses, particularly from elephant back. It has been successfully used in Nepal and has developed rapidly in recent years incorporating computer analysis of the field data (Caughley 1977, Burnham *et al.* 1980, Anon. 1981, Seidensticker 1976, Mishra 1982 and Tamang 1982).

(vii) Absolute densities for many diurnal species can also be estimated from sweep/drive censuses of smaller patches of forests (Overton 1971) since manpower is not a constraint at Bandipur.

(viii) For thinly distributed diurnal species e.g., dhole, bonnet macaque, four-horned antelope, systematic observations of previously marked animals may yield home-range size and hence absolute density estimates. For nocturnal, thinly distributed, or hard to observe species e.g., civets and lesser felids home-ranges and absolute density estimates can be obtained by repeated recapture of marked individuals in a series of traps (Overton 1971, Begon 1979 and Anon. 1981).

In conclusion, I must stress here that my analysis does not deny the spectacular success of 'Project Tiger' in Bandipur. It has the limited aim of evaluating the present census techniques so that more scientifically valid methods are evolved. Such methods will be more appropriate for quantifying the undisputed success achieved by wildlife managers during the last decade in Bandipur and elsewhere in the country.

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A CONTRIBUTION TO THE BIOLOGY OF THE HOUBARA (*CHLAMYDOTIS UNDULATA MACQUEENI*); SOME OBSERVATIONS ON 1983-84 WINTERING POPULATION IN BALUCHISTAN[1]

Afsar Mian[2]

(*With three text-figures*)

A carefully prepared questionnaire was circulated to persons in different parts of Baluchistan, and the data received from 42 persons were analysed with respect to distribution and population levels, population decline, food and feeding behaviour, roosting, responses to disturbance, trapping and domestication, and migration of the population of the Houbara Bustard (*Chlamydotis undulata macqueeni*) wintering in Baluchistan.

INTRODUCTON

The desolate valleys of Baluchistan (Pakistan) have been recognized as a main wintering resort for the Asian race of Houbara Bustard, *Chlamydotis undulata macqueeni* (Ali and Ripley 1969, Siddiqi 1972). A gradual but rapid decline in all global populations of this bird (Collar 1980) and especially in Punjab (Mirza 1972, Goriup 1980), Sind (Surahio 1981, 1982, 1983), and N.W.F.P. (Roberts and Savage 1972, Malik 1983, Khan 1983), attracted us to this species in Baluchistan. Our researches during the past two years (Mian and Surahio 1983, Mian and Rafique 1984, Mian 1984a, Mian and Dasti 1984) suggested that this region is important in the world conservation map of this species, as it still holds a reasonable population and potential for the presence of a limited breeding activity (Mian 1983, 1985a). As research progressed our interest in the biology of this bustard mounted, with the hope that it would provide a sound base for a well planned conservation strategy. This report considers a part of data collected on biological and ecological aspects of the population of Houbara wintering in Baluchistan during 1983-84.

MATERIAL AND METHODS

A carefully prepared questionnaire with questions on various aspects of the biology, ecology and declining trends of the Houbara was circulated through the Provincial Forest Department to be filled up by the Forest Guards/Game Watchers based on the observations on the populations of the bird wintering in their respective areas during the 1983-84 winters (facsimile of questionnaire, Appendix I). The questionnaire was also circulated among well known hunters and the local populace. A carefully drafted questionnaire helps in collection of a large body of information, especially when a total survey is not feasible over such an extensive terrain as in Baluchistan with limited financial resources. In all 42 individuals responded, from Zhob, Pishin, Quetta, Chagai, Kharan, Bisemah, Panjgur, Gwadar, Kohlu, Dera Bugti, Sibi and Kachhi. No information, however, was received from Loralai and Lasbella districts.

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The reply to each question was tabulated. Some of the observations were irrelevant and were eliminated from the final analysis after giving due weight to the status of the reporter. Various countercheck questions for the observations helped in selecting the right ones for the final analysis. Information regarding local and visiting hunters, generally seemed to be inadequate, because of the local ban on hunting and official quota alloted to foreign hunters, and hence was not subjected to the analysis of hunting pressure. The data regarding the take of the local and foreign hunters was collected through direct contact with the guides to the visiting falconers in the area, and local hunters.

RESULTS AND DISCUSSION

Distribution and Population Levels:

The Houbara Bustard has a very wide distribution in Baluchistan during the winter months and can be seen everywhere, except for the tops and slopes of the mountains and certain narrow valleys (Table 1, Fig. 1). As the northern part of the province is mainly occupied by Suleiman and Toba Kakar ranges, the favourable bustard tracts are very limited in Zhob (Patao), Pishin (Dolangi and Margakti) and Quetta (Karram) districts. Vast desert steppe valleys occupy most of the southern part, hence the bird exhibits a wider distribution in Chagai, Kharan, Sibi, Kohlu, Kacchi and Makran districts. The presence of various mountain ranges limit bustard population to specific areas in Khuzdar, Punjgur and Bisemah. These findings suggest a much wider spread of wintering population of the species than that anticipated by Roberts and Savage (1972; Makran and Lasbella) and Siddiqi (1972, Maslak, Quetta), and partly confirm the distribution proposed by Mian (1984a), as seen from the hunting successes of the Arab falconers.

The data suggests that though a basal population level of the bird persists in all favourable bustard tracts of Baluchistan, throughout winter (October-March), the peak level is restricted to specific periods, depending upon geographic location and physico-biological factors. Generally in northeastern parts (Zhob, Quetta, Pishin and Nushki) the peak levels are restricted to migratory fluxes, the population of the bird being very low during the rest of the wintering period. Thus, high population is present in Quetta during March-April, and in Zhob, Inam Bostan (Nushki) and Pishin during November-December and February-March. Reasonably high population levels persist throughout wintering period in central and western Chagai, Kharan, Punjgur, Sibi and Kachhi areas, though limited to mid winters (January-March) in southern areas of Gwadar. Such a population fluctuation is understandable. because the northern areas, though lying on the migratory routes (Mian and Surahio 1983), have few valleys with favourable bustard habitat, thus forcing the bird to the southern and eastern areas to pass the major part of the wintering season.

The wintering population of the Houbara exhibits considerable fluctuation in density and dispersion depending on physical conditions present in the specific area. Though the extensive favourable bustard tracts of western Chagai (between Baldandin and Koh-i-Sultan), are famous for bearing a rich population of Houbara throughout winter and as hunting ground for Arab falconers, the present meagre population can be attributed to persistent drought. The information conveyed suggests the presence of good bustard population till January, 1984, and the absence of newly sprouting herbs due to drought has probably forced them to migrate to the southern areas of Urmagai, Washuk and Kharan, which had received scattered rain. The pattern of popu-

TABLE 1

DISTRIBUTION OF FAVOURABLE HOUBARA BUSTARD TRACTS, POPULATION LEVELS AND DISPERSAL STATUS OF WINTERING AND SUMMERING POPULATIONS IN DIFFERENT REGIONS OF BALUCHISTAN, BASED ON OBSERVATION OF 1983-84 WINTERING POPULATION

Major Areas	Fields with reasonable bustard population	Wintering Population			Summering population level
		Population	Dispersal status	Period of stay	
Zhob	Patao*	Rich	Clumped	November & March-April	Rare, Singles
Pishin	Dolangi Margakti*	Low Moderate	Clumped	Sept. to April	Not seen
Quetta	Karram*	Low Moderate	—	March to April	– do –
Chagai	Inam Bostan Dak Padag Pul Chotao Kambran Game Reserve Gat Game Sanctuary* Nokkundi Koh-i-Sultan Shikar Dal Mashkhel Essa Chah	High Moderate	Clumped	Sept. to April	Very few
Kharan	Everywhere, Urmagai* Jalwar* Jhalawan*	Very Rich	Very clumped	Sept. to April	Few
...Bisemah	Bisemah Mashkey Zaddi	Poor	Dispersed	Nov. to March	Very few till March
...Gwadar	Jiwani Plairi Chittani Chitti Ikharah Dam Pishal Dar Bella Kollunchi Sar-i-Dasht Ball Nagoor*	Poor	Dispersed	Jan. to March	Nil
Kalat ...Khuzdar	Karrah Wamashky Kawartak Mula Kurkh	Poor	Dispersed	Sept. end to April	Very rare

TABLE 1 (contd.)

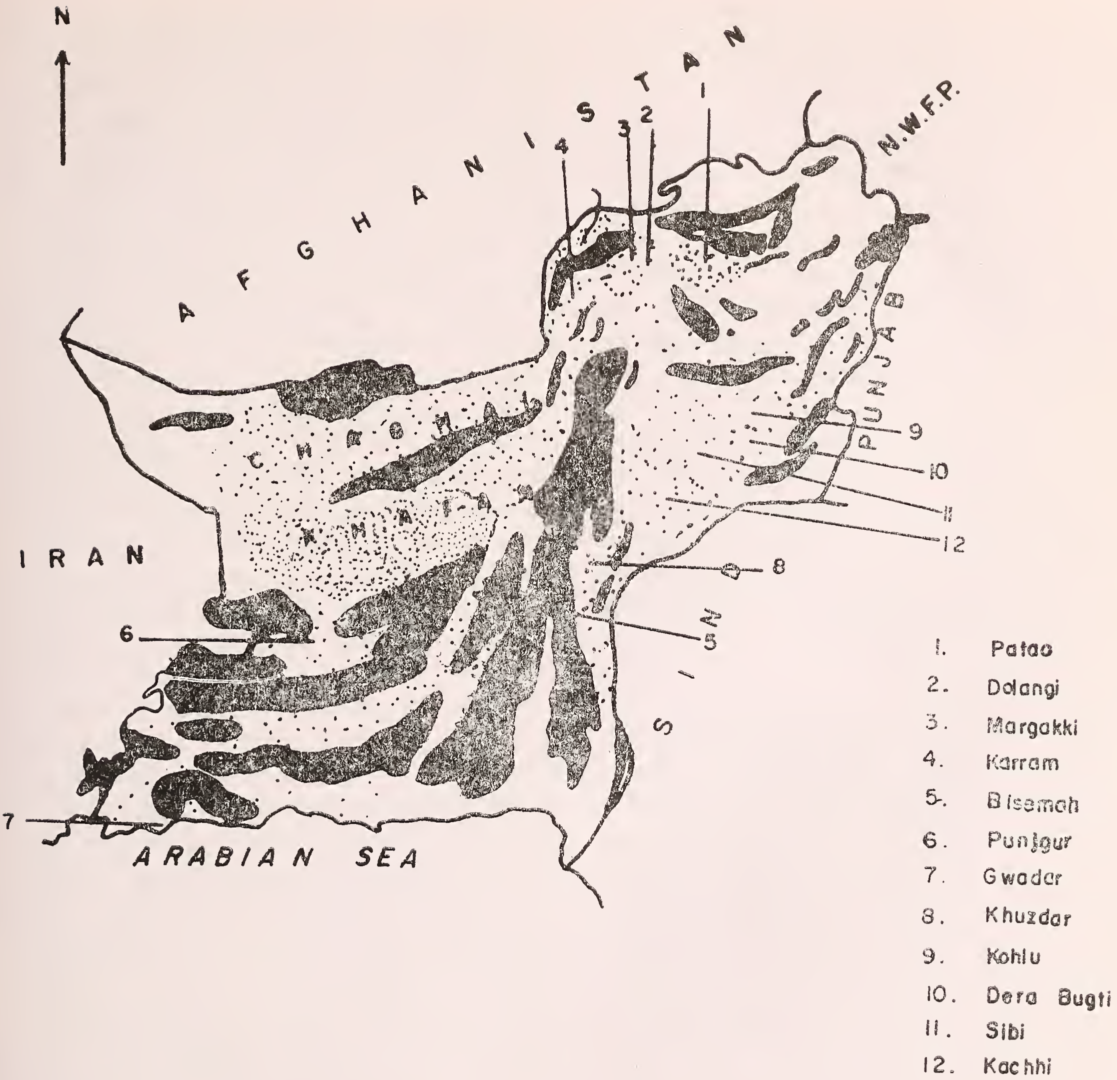
Kohlu	Sui* Pat Feeder Tomba* Bohri Subvand Safeed Garsi Pazza Berakh	High Moderate	Much dispersed	Nov. to March	—
...Dera Bughti	Dasht Goveran*	Poor	Dispersed	Oct. to March	—
Sibi	Kark Kot Parouzi Much Lehri Pat Wamber	Low Moderate	Clumped	Oct. to Feb.	Seldom, probably injured birds
Kachhi	Saryani* Bagh Gandana All other areas with mustard or *Eruch* sp.	Low Moderate	Dispersed	Sept. to March	

* indicate the tract with a relatively higher bustard population.

lation fluctuation stands confirmed through our observations in November, 1983, and from the activities of Arab falconers, who exploited Chagai area in December and Kharan for the rest of the winter. The reports of Kharan receiving a higher bustard population than previous years can be attributed to persistent drought and lack of sufficient vegetation in adjacent areas of Chagai, and to some precipitation during early winter and better vegetative cover in Kharan.

The peak levels of bird population varies in different areas with topography and a number of biological factors, such as vegetative cover, vegetation type and human disturbance. The peak wintering population can be regarded as very high in Kharan (average of 60 birds spotted during a day's walk); high to moderate in Chagai and Kohlu (25); moderate to low in Pishin, Sibi and Kachhi (15); poor in Khuzdar and Gwadar (8); and very poor in Punjgur (2-4). Our findings can be corroborated with hunting successes/activities of Arab falconers, who claimed a high toll of houbaras in Kharan, whereas no party visited Khuzdar, Gwadar and Punjgur. The exact significance of the various factors contributing to the differential status of wintering populations in a specific area needs to be studied.

The dispersal of wintering population, as indicated by size of groups, varies in different tracts of suitable habitat. Thus our data indicates that the population of the bird is very clumped (15-20 birds per group) in Kharan; clumped (10-15) in Zhob, Pishin, Chagai and Sibi; dispersed (4-8) in Bisemah, Punjgur, Gwadar, Dera Bugti and Kachhi; and very dispersed (1-4) in Kohlu. It appears that population level and dispersal status of bustard are correlated, indicating that both are decided by the environmental factors. Thus optimal vegetation cover and related factors may attract larger population to the area and provide adequate food/shelter so that the incoming groups are not forced to disperse.


N
AFGHANISTAN
N.W.F.P.
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1. Patao
2. Dolangi
3. Margakki
4. Karram
5. Bisemah
6. Punjgur
7. Gwadar
8. Khuzdar
9. Kohlu
10. Dera Bugti
11. Sibi
12. Kachhi

Fig. 1. Line sketch of Baluchistan showing the relative distribution of bustard population. The dots indicate bustard density and filled spaces the approximate location of the mountains.

It appears that the Houbara is attracted to different plant species in different areas. Thus, in Sibi and Kachhi areas its population is concentrated around cultivated fields of *Brassica campestris* (mustard), and *Eruca sativum* (Jamba), whereas in areas adjacent to Dera Ghazi Khan it is attracted to *Capparis decidua*, partially confirming earlier reports of Surahio (1983) for Houbara, and Ali and Rahmani (1983) for the Great Indian Bustard. Further studies on ecological correlation between population density/dispersal of Houbara and plant type/cover may yield interesting results.

The available information shows that the population of this bustard summering in Baluchistan is very less. Virtually no summering population of Houbara is present in the major part of the province. The very rarely seen birds in areas such as Khuzdar, Sibi, Kacchi and Bisemah are believed to be injured ones, incapable of accompanying the spring emigrants. However, evidence is accumulating that occasionally a few birds do spend the summer in Chagai and Kharan, though these may also show some degree of local migration in accordance with the occurrence of suitable vegetation. These observations agree with similar earlier reports (Ali and Ripley 1969, Roberts and Savage 1972, Siddiqi 1972).

Population Decline:

The information collected through questionnaires and interviews with hunters and tribal chiefs suggests that there has been an obvious decline in the population of this bustard during the last 10-12 years, and the trend is becoming more pronounced with the passage of time. Most of the observers associate this decline with the onset of Arab falconry in the area. These observations are shared by workers throughout the world (Collar 1979, 1980), in Pakistan (Goriup 1981, Surahio 1983, Malik 1983, Khan 1983), and in Baluchistan (Mian and Surahio 1983, Mian 1984a). However, though reports from Soviet Russia (Alekseev 1980, Ponomareva 1979), and from Punjab and Sind (Goriup 1981, Surahio 1982) indicate that the declining trend started some 20 years ago, it became apparent in Baluchistan only in the last 10 years or so. The fact that Arab falconers started exploiting the area quite late may account for this.

Three reports from Khuzdar indicated that the population of the Houbara is not decreasing, but is actually on the increase, though an equal number of reports from the same broad locality maintained that the bird was on the decline, suggesting that the increase reported might be a chance observation; but even if the reports are believed they may not conclusively indicate an actual increase in the overall population. The presence of an apparently higher population in these very limited tracts could be easily attributed to certain specific local factors, including less hunting pressure and/or other biological factors like favourable feeding conditions, which may attract the bird from the surrounding, less favourable areas to these isolated pockets. There have been a number of reports of such local population shift resulting in a higher population density in isolated pockets than in the surrounding areas.

The decline in the abundance of wintering Houbaras has been rapid in almost all the regions for which reports are available and the population of the bird is believed to be much less now than some 10-12 years ago. Rough estimates of the declining rates obtained from casual observers in different parts of the province indicate a declining rate between 5% and 25%, averaging around 10% per annum. Some equivalent decline has been suggested for Sind (Surahio 1982) and Iran (Scott 1975). This rate of decline is higher than what Goriup (1980) has estimated for Cholistan area. The decline rate of 10% per annum is calculated to reduce the population to 39.65% in 10 years and to 32.11% in 12 years. The declining rate in its winter quarters seems to be closely matched by the breeding population in its homeland as the population in Kyzylkum (U.S.S.R.) has been reduced to 25% of the 1965 population level (Ponomareva 1979).

The decline in the population levels of the

Houbara has been generally ascribed to destruction/increased human disturbance of/in its traditional breeding grounds, habitat loss, sheep/goat competition (Ponomareva 1979, Haddane 1983, Mirza 1983), but mainly to hunting pressure (Roberts 1983, Khan 1983). The extent of hunting pressure present in its summering as well as wintering grounds is hard to fully ascertain. There is definitely a considerable hunting pressure on the Houbara population in its summering grounds in U.S.S.R. as well as its wintering grounds in Pakistan and an enforcement of a total ban on local hunting is difficult to execute. However, the present data indicates a clear decrease in activities of local hunters, which may be partially attributed to legislative action and partly to general awareness of the local hunters and prominence given to the species, through efforts of the Forest Staff and our talks with local populace during our field trips in the past three years.

The major hunting pressure on the bustard is, however, attributable to organized falconry. The evidence for a direct correlation between falconry and population decline is hard to collect, but the fact that there is no noticeable decline in population levels of the birds wintering in Khuzdar, where no falconry party has visited, suggests that the decline in the hunted areas is due to the intensive hunting. The only other areas which have not been exploited by falconers include Quetta and Pishin, but both these receive only migratory flocks. The population decline in these areas may be attributed to falconry in other parts of the province. Further, the greater decline reported from Kohlu, Dera Bugti, Sibi and Kachhi than from other regions of Baluchistan may be reasonably attributed to the longer period they have been exploited by falconry parties, whereas Chagai, Kharan, and Punjgur have only recently attracted their attention.

Hunting Pressure:

The extent of hunting pressure from local hunters is difficult to assess because of a ban imposed on hunting of the Houbara by local hunters. The information given to us by the local hunters and prominent people of the different areas suggests that the local hunters did not claim more than 400-500 birds during 1984-85 wintering season in Baluchistan. This seems understandable because the resources available to local hunters are meagre and only a few prominent tribal chiefs can afford car transport. Most of the hunters depend on motor cycles. Further, decreased population density of the bird and its protective coloration makes the hunting very difficult. The number of the Houbara killed by local hunters is on a gradual decrease, partly because of the legal ban on hunting by local hunters and partly because of the general decline in the number of the birds. One of the hunters expressed this fact by saying that whereas previously one could capture some 15-20 birds in a day in the Pishin area, now the occasion is celebrated if a hunter manages to capture even a single bird.

Correct information as to the exact bag size claimed by visiting Arab falconers is also very difficult to collect due to security and secrecy maintained in the hunting camps. The data of hunting successes of falconry parties in different areas (Table 2) suggest that during the 1983-84 winter they claimed 3,961 birds from the area. This hunting toll seems minimum as it mostly pertains to the prominence of the party and does not include the bag of hunters of secondary importance in camp hierarchy, who take their quarry to individual camps. Further, some of the informers were very reluctant to give information, fearing the loss of their source of income. When all these facts are considered, it would not be unreasonable to suggest that approximately 5,000 birds were

TABLE 2

HUNTING SUCCESSES OF THE ARAB FALCONERS IN DIFFERENT AREAS OF THE BALUCHISTAN, DURING 1982-84 WINTERING SEASON

Area	Number of Falconry parties	Number of birds captured*	Total days hunted*
Chagai	1	510	25
Kharan	5	2702	72
Sibi	2	432	—
Dera Bughti	1	62	—
Kohlu	1	25	—
Punjgur	1	85	—
Zhob	1	80	—
Gwadar	1	65	—
Total	13	3961	

* Data regarding the main falconry party only.

taken by the Arab falconers in this region in the 1983-84 winter.

The above figure does not appear to be a gross overestimation of the factual position. This is because of the fact that there is still a reasonable population of the bird concentrated in certain restricted tracts of favourable habitat where there is very limited human disturbance. Other important factors responsible for the mass slaughter of the bird are the modern facilities available with the Arab falconers for swift and far-ranging movement and the competition among the various royal hunters for the largest bag. Further, the hunting is organized through radio communication and hectic efforts of the local guides. Despite all these facilities, an average of 0.7741 birds is claimed per hunting vehicle-day in specially favourable tracts by very well organized parties. These figures are considerably lower in relatively less favourable areas.

Food and Feeding Behaviour:

The majority of data collected agrees with earlier reports that the bird is omnivorous (Ali & Ripley 1969, Collar 1979, Mian 1983), consuming seeds and young shoots of a variety of plants, and animals, especially slow moving insects and some reptiles. The bird exhibits variation in its food, as per availability of animal/plant material in an area. Houbara consumes *Salsola* sp., *Haloxylon* sp., *Anabasis* sp., *Malcolmia* sp., and *Tribulus* sp. in Zhob, Pishin, Nushki and Kharan, thus confirming our previous findings (Mian & Surahio 1983, Mian 1984a) and results obtained from gizzard content analysis (Mian 1986). In lowland deserts of southern and eastern Baluchistan (Gwadar, Dera Bugti, Sibi, Kachhi), the species depends on the berries of *Zizyphus* sp., seeds of *Brassica campestris, Capparis decidua* and *Eruca sativum*, supporting earlier reports from Cholistan (Mirza 1972) and Surahio (1981, 1982, 1983). Our data suggest that the bird consumes a reasonable proportion of animal matter (insects, beetles, mole cricket, ants, grasshoppers), though no lizard/snake was recovered from gizzard contents. This goes against the observations of Mirza (1972) and in favour of those from summering grounds (Alekseev 1980). Further detailed study on gizzard contents collected at different times of the year and from different areas may yield interesting results on energy and water budgeting of the bird.

The diurnal period of maximum activity of the bird coincides with the period of feeding. The main body of information suggests that the bird is mainly active during the day, but the time budgeting seems to be reasonably done in accordance with the surrounding conditions of temperature and light, availability of food and human and grazing disturbances. If conditions allow, the bird is active throughout the day, even at noon and afternoon and even at night. However, the bird generally prefers to be inactive during dark nights and during mid-day. There are indications suggesting that the Houbara in its wintering grounds does move about during moonlit nights, specially when disturbance during the day has prevented normal foraging. Thus, there are persistent reports of the bird feeding mainly during night from Pishin, Quetta, Nushki. This behaviour is presumably due to the general disturbance caused by dense human and livestock population in all these areas. The nocturnal feeding of the bird in cultivated fields reported from different areas, including the remote parts of Baluchistan may also be partially due to the same cause.

The major activity of the bird seems to be restricted to the cooler morning and evening hours. The feeding activity of the Houbara starts just before sunrise and lasts till approximately 11.00 a.m. The evening session starts from about 4.00 or 5.00 p.m. and lasts till a little after sunset. During the colder months, i.e., January and February, the bird is active and forages throughout the day, which may be necessary due to the shorter day length (from 7.00 a.m. to 5.00 p.m.) and the milder temperature during mid-day. Observations indicate that the bird is more active during the morning foraging session than in the evening. These observations agree with those of van Thanner (1912, 1913), regarding the Canary Island race of the Houbara.

Drinking:

From the experience and casual observations reported by the local populace and from the previous findings of Mian & Surahio (1983) in different areas of Baluchistan it would appear that the Houbara is not an obligatory drinker. All the informations suggest that though the bird is not a regular visitor to water bodies at fixed times of the day as the sandgrouses are, and can pass long periods without drinking, it may on rare occasions take water, if available. Further studies may indicate some correlation between the type of food consumed and the requirements of water by the bird.

Roosting:

Most of the replies received in response to our questionnaire, from different parts of Baluchistan suggest that the bird has a general tendency to spend the hotter parts of the day, i.e., usually from 11.00 a.m. to about 4.00 or 5.00 p.m., and nights, especially dark nights, at some protective resting place. The hours of roosting are, however, adjusted in accordance with the surrounding conditions and the physiological demands of the bird. The Houbara Bustard, like other bustard species including the Great Indian Bustard (Ali and Rahmani 1983) do not have a permanent nesting or resting place; but during the period of unfavourable environmental conditions or after foraging, the individuals select a roosting place for themselves. This is generally on an open plain, from where the bird can spot an approaching predator at a reasonable distance. The bird has a tendency to select a suitable bush and generally tries to hide its head first, relying fully on its protective camouflaging coloration or the body. It may even select entirely bare areas for roosting.

Many of the reports suggest that the birds do sleep in a protective bush during roosting hours. However, they indicate that the birds remain vigilant throughout the roosting period and it is hard to take them by surprise. The mid-day roosting behaviour has been frequently reported by observers from Canary Islands (Aharoni 1912, van Thanner 1912, 1913).

Response to Disturbance:

The behavioural response to a specific stimulus at a given time seems almost unpredictable. It varies with the type of stimulus, biotic and abiotic factors in the areas and psychological state of the bird, though the following generalizations can be drawn.

The bird tends to stay at a distance of 5-8 km from large human settlements. This distance generally decreases in direct proportion to the decreasing size of the settlement, and small nomadic camps have no effect on dispersion of the bird. Some strays have been reported to come in the vicinity of human settlements, especially during the night hours, when human activity subsides. On a number of occasions this was noted by us, both through direct watching and from the presence of footprints, especially around cultivated tracts. The distance maintained by the Houbara from human settlement may be decided by disturbance level. Thus, recent disturbance in desolate deserts through hectic falconry has probably forced the bird to find refuge in the vicinity of Kharan town. Similarly extensive cultivated tracts in Pishin, Nushki, Khuzdar, Sibi and Kachhi may force the bird to stay in cultivated fields and hence within a radius of 1-2 km of human settlements. Conversely, vast favourable desolate areas and relatively low bird population may allow the bird in Zhob, Panjgur and Kohlu to remain at some 16-20 km from human settlements. Though there is no definite study, the present report agrees with the general belief that Houbara avoids large human settlements and small nomadic camps have no bearing on its distribution (Ali and Ripley 1969, Roberts and Savage 1972, Surahio 1981, 1982, Mian and Surahio 1983, Mian 1984a).

The Houbara Bustard being very shy, keeps away from busy roads. It is least disturbed by grazing camels and may even be attracted towards them. Presently available data support our previous observations that the bustard is not scared by the slow and gradual approach of a haphazardly tainted structure (Mian and Surahio 1983). Grazing sheep/goat do cause some concern to foraging birds and they keep away from cattle. The birds are watchful and use their obliterative camouflage to hide. They are little disturbed by a slow moving and indirectly approaching automobile, but, fast moving, noisy vehicles alarm the birds and cause them to fly away. The bird will hide or fly away from even a slow moving vehicle, if it has been recently chased.

The Houbara tolerate the least a man moving on foot, walking away immediately and maintaining definite distance. It may keep walking ahead of a man, especially in a dried water course, hide in a bush, squat on the ground or may even fly off, if approached closely or if it had been disturbed previously. A man moving along with grazing sheep/goat/camel causes less alarm to the Houbara and this is exploited by local hunters. The average flight distance of the houbara in Baluchistan is about 300 m. However, this distance varies considerably with the population level of the bird, general disturbance and extent of falconry in the area. Thus, in Kharan with limited hunting activity and higher population levels of bustards some 10-12 years ago, the Houbara frequently allowed human approach to within 20-40 m. With the onset of massive hunting and decreased bustard population in the area, a man can hardly approach the bird to a distance of 100 m. In the presence of a specific blend of interacting factors to Houbara now allows human approach to 100-200 m in Zhob, Kohlu, Sibi, and Quetta; to 200-300 m in Pishin, Nushki, Bisemah, Gwadar, Kachhi and Khuzdar; and to 600-1000 m in Punjgur.

The data suggests that the bustard has variable reaction to the same stimulus, depending on its previous experience. The bird, generally, walks briskly or runs away when alarmed, with outstretched and lowered neck and watchful eyes, taking full advantage of the camouflaging effect of its plumage, deceptively high speed and shrub cover. However, if continuously alarmed the bird flies away, settling at a distance of about 200-800 m where it immediately runs to cover.

The Bustard reacts in particular manner on sighting a falcon. On seeing a flying falcon, the Houbara immediately squats, relying on its protective camouflaging colour. Among shrubs it prefers to protect its neck, rather than the body, probably to avoid a direct stoop on the head. On flat ground the neck is kept flat on the ground, with the hind part of body slightly raised. The Houbara remains remarkably still, as long as the falcon remains in the vicinity, on rare occasions, local people catch such a bird, and one of the hunters from Kharan claimed to have caught four birds with bare hands from one spot. Such behaviourial response might save the bird from a possible disastrous reduction in number through falconry. When a bustard is being chased by a falcon, all other bustards in the area squat motionless and hidden, thus escaping the eyes of the battery of radio coordinated falconers present in 3-5 hunting vehicles, capable of releasing 10-20 falcons if the bustards are spotted. Our data agree with previous reports that the Houbara squirts a gummy anal fluid when pursued by a falcon (Ali and Ripley 1969). A report from Kachhi stated that a Houbara lying on the ground, when detected by an approaching falcon, squirts gummy anal liquid, by raising its hind part with a jerk, causing temporary blindness to the falcon! A flying houbara, on seeing the chasing falcon, immediately tries to fly upward to avoid a possible stoop from the falcon, but bustards seldom succeed in escaping.

Migration:

The information received from different areas and workers, when analysed allows us to propose migratory routes (Fig. 2), which generally agree with those suggested earlier (Mian and Surahio 1983). The observations so far made, persistently suggest a general north-south autumn migration through very diffused routes, extending from northern Zhob to western Chagai (Azar Chah). This is consistent with earlier reports (Mian and Surahio 1983, Mian 1984a, Goriup 1980) but do not agree with Roberts and Savage (1972), suggesting well defined routes, occurring around the plains of Muslimbagh; and Anonymous (1972) and Karim and Hassan (1983), presuming Iranian origin for the population of Houbaras wintering in Baluchistan. During the return migration in spring the bird follows almost the same routes, though more directly. Our present data partly supports previous hypothesis (Surahio 1981, 1982, 1983) that the population of Houbara wintering in Sind pass through central Baluchistan (via Sibi and Kachhi), though no convincing evidence is available suggesting that the wintering population of Dera Ismail Khan (N.W.F.P.) passes through northern Baluchistan, i.e., Zhob (Malik 1983).

The replies to our enquiry persistently suggest a general north-south or south-north orientation of the autumn/spring migrating flocks, though it varies slightly as per the location of favourable bustard habitats, and orientation of mountains and very narrow valleys; the bird generally avoids passage over high mountains and narrow valleys (Mian and Surahio 1983). Thus, the Raskoh Range. forces the entry of the bird into Kharan valley from the southwestern direction; while Siahan and Central Makran ranges allow its entry into Punjgur from southwestern, and into Gwadar from almost a western direction. Relatively extensive interconnected valleys around Much allow the passage of the bird

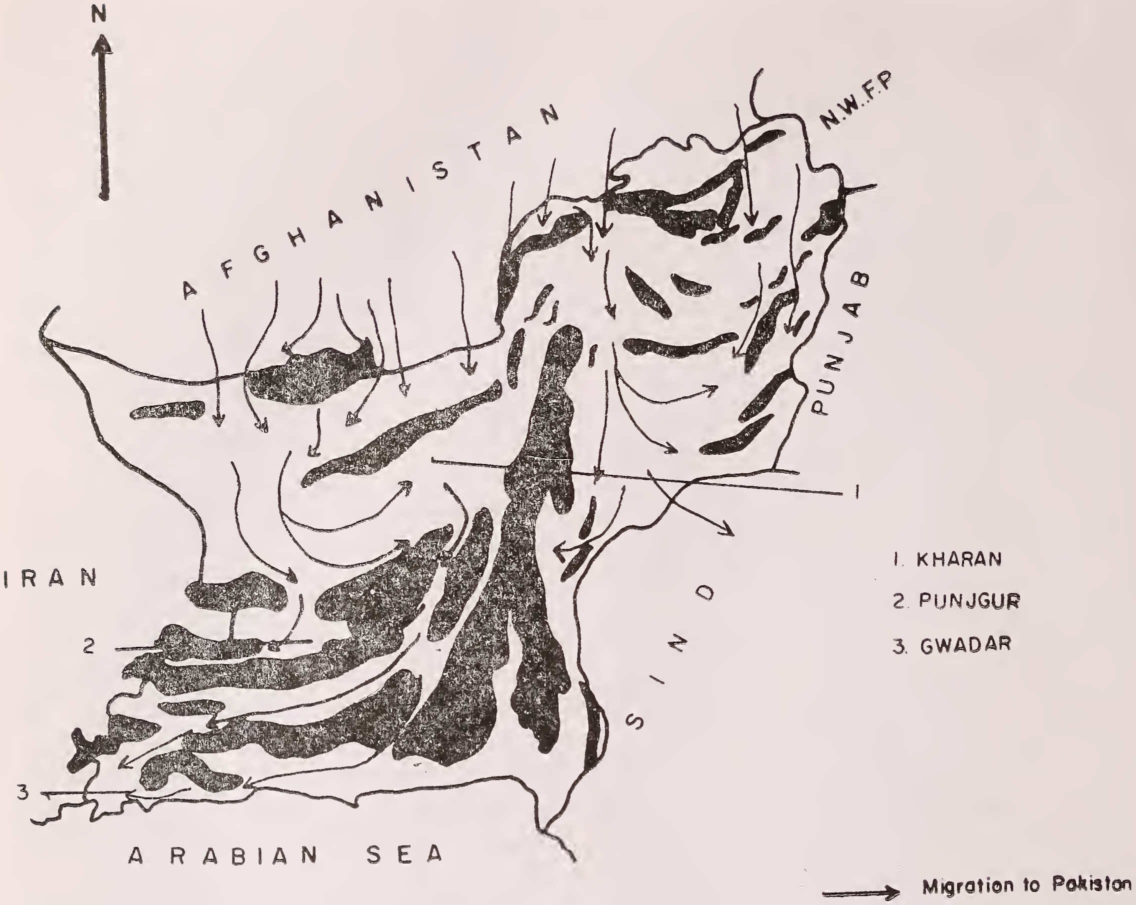

Fig. 2. Line sketch of Baluchistan showing the tentative migration routes of the Houbara Bustard.

through the Central Brahuii Range, thence reaching Sibi from a northwestern direction. Some reports indicate that the bird population wintering in Khuzdar, enter the area through the west, probably from the adjacent areas of Kachhi.

The information regarding the first sighting of the Houbara in different areas seems sketchy, casual observers being unable to record exact dates. However, data regarding tentative dates of the arrival of first migrants in different areas suggest that the autumn migration is a rather slow process and birds continue moving gradually towards southern latitudes. The birds arrive in September in northern parts (Chagai, Pishin; some sporadic birds recorded in mid August), towards the end of September or early October in central parts (Kharan, Sibi, Kachhi, Khuzdar), during mid- or end of November in southern parts (Bisemah, Punjgur), and the birds are not frequent till January in extreme southern parts (Gwadar; sporadic birds recorded in November). This indicate that the birds generally arrive earlier in northern latitudes and later in southern latitudes. These observations largely agree with the previously available reports, suggesting that Houbara starts migrating from U.S.S.R. in early September (Ponomavera 1979) or even the first half of August (Messurier 1904) reaching northern Baluchistan in late September or early October (Mian and Surahio 1983, Mian 1984) and continue moving deeper into the province after consuming available food in the area (Mian and Surahio, loc cit.) reaching Punjab and Sind in October (Roberts and Savage 1972, Mirza 1983, Surahio 1983).

The precise dates of onset of spring migration are hard to record. It appears to start in March in all the parts and is complete by early April, suggesting that it is more abrupt than the autumn migration. These migrants reach summering grounds in U.S.S.R. towards the end of March or by mid-April (Alekseev 1980).

The present data confirm our earlier hypothesis (Mian 1984) suggesting a larger size for the autumn migrating flock in northern areas and dispersal of the birds causing a smaller flock size in the southern areas. The size of immigrating flocks seems to be directly proportionate to the distance travelled to the wintering grounds (Fig. 3), so that flocks of 15-25 observed in northern parts (Zhob) decreases to 10-15 in Pishin, Chagai, Kohlu and Kharan; 8-10 in Sibi and Kachhi; 4-8 in Bisemah and Khuzdar and 4-6 in Gwadar. The data collected by Alekseev (1980) suggest that, at the onset of autumn migration 63% of the birds are in ones and 24% in twos, while leaving the summering grounds. The correlation of our results with those of Alekseev (loc. cit) suggests that the larger flocks are formed during migration, and secondary dispersal occurs in the wintering grounds, probably due to intraspecific competition. The exact significance of this migratory behaviour is hard to explain and need further studies.

The information conveyed regarding the size of spring migrating flock suggests that it is smaller than of the autumn migrants. Generally it ranges between two and eight. This observation is in sharp contrast to our previous report suggesting that the size of the spring migrating flock is larger (Mian and Surahio 1983). Though further data would reveal the exact situation, our present data provide a better explanation, as the spring migration is rather direct and reports from summering grounds indicate that birds reach in ones (50%), twos (20%) and 3-8 (30%), (Alekseev 1980).

Trapping and Domestication:

The data indicate that very limited trapping is being practised in Baluchistan. During recent years, decreasing population of Houbara has rendered this hobby as time consuming, tiresome and with little chance of success. Distribution of firearms and automobiles has, on one hand, increased the hunting pressure, while on the other hand decrease in trapping success is due to the associated disturbance. Trapping is reported to be possible but difficult, the birds being very clever, cautious and extra-vigilant. Apart from triangular enclosure of local bushes with net used in Chagai and Kharan (Mian and Surahio 1983) and net laid on ground as in Kachhi, Sibi, Kohlu, Dera Bugti and Pishin (Mian 1984a) the affinity of the bird for *Capparis decidua* is exploited in northeastern flank of Baluchistan and adjacent areas. An isolated dense bush of the plant is selected and netted all around except at the side where it is curved into a V-shaped entry point. The bird is attracted towards this plant from long distances and by habit enters the bush through the open end and is finally trapped. This technique is quite effective, requiring less physical labour.

There is no information that the Houbara is kept as a domesticated bird. It is generally

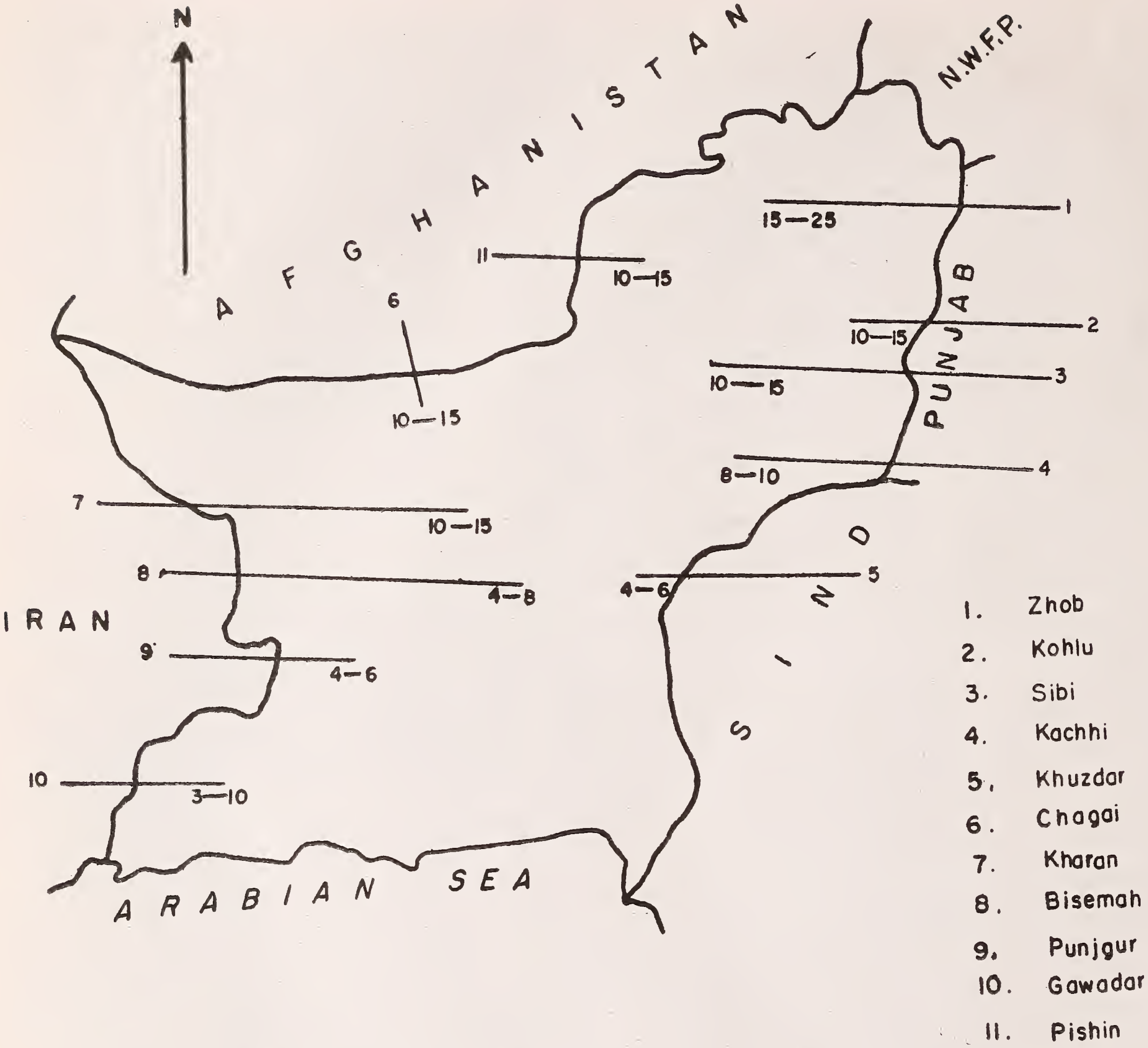
N
AFGHANISTAN
N.W.F.P.
PUNJAB
SIND
IRAN
ARABIAN SEA
1 15—25
2 10—15
3 10—15
4 8—10
5 4—6
6 10—15
7 10—15
8 4—8
9 4—6
10 3—10
11 10—15
1. Zhob
2. Kohlu
3. Sibi
4. Kachhi
5. Khuzdar
6. Chagai
7. Kharan
8. Bisemah
9. Punjgur
10. Gawadar
11. Pishin

Fig. 3. Line sketch of Baluchistan showing the size of autumn migrating flock in different areas of the Province. The figures in the map represent the number of the birds in the flock.

believed that the bird cannot be kept as a pet, and it has been kept in captivity for only 10 days. The trapped birds are either eaten by the trapper or presented to an influential person as a delicacy.

Flock Formation:

Though the Houbara is gregarious in its wintering ground, forming flocks of various sizes in different areas, individual birds maintain a reasonable distance from one another. The flock size varies from 5 to 40 in different areas and is decided by population level of the bird and suitability of habitat. Rarely, flocks of larger size are also observed. Luckily, we saw a rare flock of 500-800 birds flying over the area around Yakmuch (Gala Chah). This flock started appearing as a few birds in flight and the size of the flock gradually increased. The flock was observed for some time, when the hovering birds made fascinating pattern of brown and white. The cause for the formation of such a large flock could not be ascertained except that some hunters with powerful motor cycles were believed to be present in the area. Our discussions in Kharan suggested that such large flocks can sometimes be seen in favourable bustard tracts in the deeper western parts, though the appearance of such large flocks is gradually becoming a very rare phenomenon.

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Thanks are due to M/s. K. M. Shams (Chief Conservator), M. Shafiq (DFO, Wildlife), Arbab Inayat Ullah (SDFO, Wildlife) and a number of workers of the Provincial Forest Department, whose unstinting help made this study possible.

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Annexure I: Facsimile of the questionnaire. (English translation of the original circulated in Urdu).

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QUETTA

Note: Houbara is called in Pushto *'Sar', Zar'*; in Baluchi 'Charaz' and in Urdu, Punjabi and Sindhi *'Taloor'*.

Your name ....

Locality (Full address) ....

....

....

1. When did you see the first Houbara this year? Please mention date and month.
2. What was the size of the incoming group?
3. What is the part of the day exploited by the incoming bird? Day/night; moonlit night/dark night.
4. What is the direction of the incoming group?
5. Does this bird remain in your area throughout the wintering period? If not, at what part of the year can the bird be seen in your area, and in which direction it leaves the area?
6. What is the major type of terrain in your area: hilly/plain; sandy/stony; hard/loose?
7. What are the dominant plants of your area? (Please mention local names).
8. Is the major part of the land in your area barren or arable?
9. What are the bustard tracts in your area (mention names)?

10. What does this bird eat?
11. What part of the day is exploited by the bird for its feeding activity?
12. What is the part of the day when maximum number of birds can be seen?
13. What is the maximum number of the birds you have seen in a day. (specify area in which seen)?
14. What is the usual size of the flock in different bustard tracts?
15. What is your approximation regarding the number of the birds visiting your area during this wintering season? Were they more or less than the previous years?
16. Have you ever cared to examine the type of food present in the gizzard? If yes, what were the major food items?
17. Does this bird sleep? If yes, where?
18. Have you ever seen the bird drinking water?
19. Can the bird be live-trapped: If yes, what technique is exploited?
20. Have you ever kept the bird as a pet? If yes, how?
21. What is the total number of the birds captured by the local hunters? If possible, please indicate the number of the males and females separately.
22. What was the number of parties of foreign hunters that visited your area? Please indicate the number of hunting vehicles, falcons, number of the Houbara hunted, any other wild animal hunted. If possible, please indicate the number of males and females separately.
23. In your opinion, is there a declining trend in the population of this bird in the last ten years?
24. What is the approximate distance from which a bird flies away on seeing a man?
25. What is the approximate distance which is being maintained by the bird from human settlement?
26. What is the reaction of the bird to grazing livestock or jeep etc.?
27. Does the Houbara lay eggs in your area? If yes, where (Name the area), when (Name the month or season)? What was the number of eggs in the nest you spotted? Were the nests in bushes or on the ground? What was the shape and size of the egg? Mention colour also.
28. In your opinion what is the total number of females that lay eggs in your area?
29. What is the approximate time of year used by the Houbara for returning from your area during spring.
30. Have you ever seen the bird during summer months?
31. What is the size of the flock of the spring migrants?
32. What is the part of the day exploited by the bird for spring migration?
33. What is the approximate size and colour of this bird in your area?
34. What are the major animals of your area?
35. Any other information.

Thank you for your co-operation.

THE BUTTERFLIES OF THE NILGIRI MOUNTAINS OF SOUTHERN INDIA (LEPIDOPTERA: RHOPALOCERA)[1]

Torben B. Larsen[2]

[*Continued from Vol. 84* (3): 584]

241A. **Tagiades litigiosa litigiosa** Möschler

The WATER SNOW FLAT is not rare and sometimes considerably more numerous than the other two members of the genus. It is readily recognised by the clearly defined white patch on the hindwing upperside. It flies in evergreen forest to the top of the subtropical zone and I would not be very surprised to find permanent colonies in some of the plateau *sholas*. It has the normal habits of the genus, often basking in the sun on the underside of a leaf, visiting flowers and occasionally damp patches. It is more frequently seen on bird droppings than the two others. Roosting takes place with the wings held flat on the upperside of leaves. It is found in suitable places in Sri Lanka, peninsular India, and then from Simla east to South China and Hong Kong, and south to Sundaland proper.

242. **Gerosis bhagava bhagava** Moore
(not mentioned in W-B)

The COMMON YELLOWBREASTED FLAT (more widely known under the generic name *Daimio*) is very rare in the Nilgiris and apparently most places in South India. There are only about six in the British Museum (Natural History). Hampson failed to find it, Wynter-Blyth took two at Kallar, where I have also taken two and seen one (16.vi, 29.vi and 13.vii). Both my specimens were captured when coming to water, the third one was seen sitting on a leaf in dense jungle. At the Forest Research Institute at Peechi there is a specimen bred from *Dahlbergia lanceolaria*. Apart from the Western Ghat complex the species may be found from Nepal east to Burma and Thailand and it is everywhere rare.

243. **Pseudocoladenia dan dan** Fabricius
(*Coladenia dan*)

The FULVOUS PIED FLAT is fairly common in the Nilgiris though usually not numerous and rarely found far from forest. It goes to the upper limit of the subtropical zone but is absent from the plateau proper. It is fond of flowers and bird droppings, but is not much of a visitor to water. The flight is extremely rapid, and sometimes long lasting aerial display flights are made in shady clearings. It is found in South India (surprisingly not in Sri Lanka), and then from Kulu east in China and Sundaland.

244. **Pseudocoladenia indrana indra** Evans
(*Coladenia indrana*)

The TRICOLOUR FLAT is one of the loveliest skippers in the Nilgiris, being much more contrasting in colour than the previous species. The dry season morph is sometimes deep orange with bright yellow marginal spots. The wet season form is more unicoloured but may be of a beautiful ochreous hue, especially in the female. Confusion between the two species of *Pseudocoladenia* is highly unlikely. In habits and habitats the species is close to the previous one, but it is considerably scarcer and more limited to the lowland evergreen forests.

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[1] Accepted January 1987.

[2] Snoghoj alle 29C, 2770 Kastrup, Denmark.

The distribution covers Sri Lanka, South India, then from East Nepal to Burma and Thailand. It does not appear to be a common species anywhere.

245. **Sarangesa dasahara davidsoni** Swinhoe

The COMMON SMALL FLAT is much smaller than any of the Pyrginae so far discussed. It is a rare Nilgiri butterfly apparently limited to the wetter lowland forests of the western slopes. I have taken one or two on most of visits to the Nadgani area but otherwise I have not seen it. In Sri Lanka the ecological tolerance seems much wider. Possibly *Sarangesa purendra* in India forms some sort of ecological vicariant in the less mesic Indian habitats of the genus. The species is found in Sri Lanka and South India, then again from Kangra east to Indo-China and Yunan.

246. **Sarangesa purendra pandra** Evans

The SPOTTED SMALL FLAT is found in much of peninsular India and has been involved in various taxonomic and nomenclatural confusions with the previous species. There are two Nilgiri specimens with no additional data in the British Museum (Natural History) but I have not come across it myself. At first sight it seems to form an ecological vicariant to *S. dasahara* in more dry habitats, but I have not seen either sufficiently to be quite sure. I have only met this species once when it was common enough in the Gir Lion Reserve in Saurashtra in October 1986. According to Bell both fly in the same place at the same time and in equal numbers in North Kanara. It is endemic to the Indian subcontinent.

247. **Tapena twaithesi twaithesi** Moore
(not mentioned in W-B)

The ANGLED FLAT is an unmistakable butterfly with its coal coloured upperside and strongly angled wings. The name *hampsoni* is sometimes applied to the South Indian populations. It is a rare skipper in the lowland evergreen forests, penetrating the subtropical forests, and I have only seen it six or seven times. Nearly all my specimens have been taken singly at water at Nadgani and near Glenburn, but I have seen one at Kallar. According to Bell it is very common in the area around Dharwar, but normally it is not a common species. The range covers Sri Lanka and South India, then from Sikkim east to Malaya, Sumatra and Borneo.

248. **Odontoptilum angulata angulata** Felder & Felder

The BANDED ANGLE is a beautiful skipper that is generally rather rare in the Nilgiris though widely distributed in the lowland forests tracts except for the very driest. I have never come across more than two during any single day. In habits it is not dissimilar to the *Tagiades* though perhaps rather less fond of open sunshine and more willing to visit water and baits. One of my specimens was taken on otter droppings deep inside a cave into which three male *Papilio polymnestor* had also made their way. The species is found in suitable hilly country in much of India, east to southern China and Sundaland.

249. **Caprona ransonnetti potiphera** Hewitson

The GOLDEN ANGLE is a common butterfly in the lowland forests from the mixed deciduous to the wettest evergreen. It is a very variable insect, but the variation does not seem to be linked with season in any consistent manner, though I have not studied this systematically. The species is less shy of sunlight than most of the group and males often perch along open paths and along forest edges. Here they are very pugnacious and fights are often seen. When perching, the males invariably retract their forelegs slightly, thus everting a prominent brush which makes them look as if they are bearded. This is done independently of the presence of females and the impression is given that it serves to dispense a territorial pheromone. Both flowers and damp patches are visited. I have seen a relatively small dragonfly eating a specimen of this butterfly; it is amazing that it could manage to subdue so powerful an insect. The range covers Sri Lanka and South India, with extensions to Pachmarhi and Orissa. Other members of the genus are found elsewhere in the Oriental region. Their names are sometimes quoted in older literature on Indian butterflies, and the name *ransonnettii* has been used beyond its actual range.

250. **Caprona alida vespa** Evans
(not included in W-B)

The SPOTTED ANGLE appears to be very rare in southern India but the British Museum (Natural History) contains two definite Nilgiri specimens, apparently those that were responsible for the inclusion of the name *C. agama* in Hampson's Nilgiri list. The spotted upper surfaces are very different from any of the forms of the previous species and I am certain that I have not seen it. According to Woodhouse (1952) the flight is much more subdued than that of *C. ransonnetti*. The range covers Sri Lanka and South India, then from Nepal east to South China and Hong Kong.

251. **Gomalia elma albofasciata** Moore

The AFRICAN MALLOW SKIPPER is a rare little dry zone skipper that is much more common in Arabia and Africa than it is in India. In the Nilgiris the main habitat is the mixed deciduous forest zone where the larval food plant *Abutilon* is common, and the rarity of the species is puzzling. I have also taken it at Chamundi Hill in Mysore (xii.83). The genus is monobasic and the single species is found all over Africa, southern Arabia and most of India.

252. **Spialia galba galba** Fabricius
(*Syrichtus galba*)

The INDIAN GRIZZLED SKIPPER is a distinctive little butterfly with an unusual degree of ecological tolerance that is common over much of the Nilgiris irrespective of altitude, rainfall and general surroundings. It is missing, only inside dense evergreen forest, but once there is some sort of clearing it will be colonised. The butterfly always flies low in relatively open places and is fond of flowers, occasionally coming to damp patches, but it is very unobtrusive and easily overlooked. It is essentially a butterfly of Sri Lanka and the Indian subcontinent, though a few disjunct populations exist further east. In Africa it is replaced by *Spialia mafa* Trimen with different facies but almost identical genitalia [see de Jong (1978) for an interesting monograph of the species].

HESPERIINAE

253. **Aeromachus pygmaeus** Fabricius

The PYGMY GRASS HOPPER is the smallest of the South Indian skippers and its distribution is limited to the Nilgiris, Coorg and Kanara. It is mainly found in open grassland in the immediate vicinity of forest in the wetter lowland tracts where it is sometimes common. Personally I have only taken about a dozen specimens at Kallar and on Nadgani Ghat. Like many of our smallest butterflies it is very fond of *Tridax* flowers, but I have never seen it at water. It is so small and inconspicuous that it is easily overlooked. The somewhat similar *Aeromachus dubius dubius* Elwes & Edwards might conceivably turn up in the Nilgiris as well.

254. **Ampittia dioscorides dioscorides** Fabricius

The BUSH HOPPER is an unobtrusive little butterfly of the grasslands in wetter forest formations where it may be locally common. I have seen it in Kallar and on the Nadgani Ghat though not very frequently. The golden tone of the ground colour is very appealing and quite different in tone from the other orange skippers. It is a much weaker insect than the *Potanthus* and *Telicota* and usually flies low in grasslands in search of flowers. The range is a wide one covering Sri Lanka. suitable places on the Indian peninsula, West Bengal and then east to China, Hong Kong and Sundaland.

255. **Halpe homolea hindu** Evans
(*Halpe egena*)

The INDIAN ACE is one of the most common lowland skippers in the Nilgiris, inhabiting forests ranging from the mixed deciduous to the wettest evergreen. It is seen mainly when it emerges from bamboo jungles to sip moisture from damp patches, though in the morning males may be found basking in sunshine along paths and forest clearings. Like some of the other *Halpe* it is fond of fresh cowpats and may be caught also on carnivore dung and decaying matter. The distribution covers Sri Lanka and southern India, then from the level of Sikkim east to southern China. The nominate subspecies is supposedly from Singapore, but in view of the fact that the species has not been recorded from Malaysia this seems doubtful.

256. **Halpe porus** Mabille
(*Halpe moorei*)

MOORE'S ACE has had a complex nomenclatorial history. Hampson used the name *beturia,* Wynter-Blyth *moorei,* but the valid name is as above. All Nilgiri records are from the Nadgani Ghat area, though doubtless it is found elsewhere on the western slopes in lowland evergreen forest. It is fairly common in the Nadgani area, almost as much so as *H. homolea* from which it is easily distinguished by having two cell spots on the forewing, and by its generally darker colour with a white rather than yellow band on the hindwing underside. One day I collected more than a dozen on still steaming buffalo dung on a drizzly morning. The range covers South India, then from Sikkim east to South China; also on the Andamans.

257. **Sovia hyrtacus** de Nicéville
(not included by W-B)

This skipper (the BICOLOUR ACE would be a suitable vernacular name) seems to be very rare in the Nilgiris and elsewhere in southern India where it is endemic. It is readily recognised by the hindwing underside where the basal half is cream and the marginal half brown, a bit like that of the much larger *Hyarotis adrastus.* I have a single specimen from the base of Nadgani Ghat from 23.ix. 1986 and a few more had been noted by earlier authors. I have also seen one on the Gersoppa Ghat in Kanara where the species also seems to be rare.

258. **Thoressa honorei** de Nicéville
(*Halpe honorei*)

The MADRAS ACE is endemic to southern India but is closely related to the Sri Lankan *T. decorata* Moore and to other species in NE India and Burma. It is not a common butterfly but in suitable places it will be met with in small numbers during most visits. I have taken it mainly on the Nadgani Ghat and in smaller numbers at Kallar. Mostly they have been taken in the early mornings when perching on a leaf at the forest edge or along paths but it will also visit flowers. It is a most attractive little butterfly which is quite different in pattern to all the other orange skippers of the area. The flight is very fast and damp patches are only rarely visited.

259. **Thoressa astigmata** Swinhoe
(not included in W-B)

The UNBRANDED ACE is large for this group of genera and the upperside is reminiscent of the *Hyarotis* and *Quedara*. It is a great rarity in the Nilgiris. Wynter-Blyth caught a specimen in the Nadgani area, and I collected a single male on otter dung at the foot of the Nadgani Ghat (20.vii). It looks a species capable of extremely swift flight and Bell of Kanara emphasised how rarely the species was seen in nature. It is endemic to southern India and is almost certainly strictly limited to wet evergreen forest with bamboo.

260. **Thoressa sitala** de Nicéville
(not included in W-B)

The SITALA ACE is endemic to South India from where there are records from the Nilgiris and from Coorg. Apparently the species is very rare and there are less than a score of published records of specimens, a few of these being recorded by Hampson. I know nothing about the species, but it is almost certainly limited to the wetter evergreen forests at low levels.

261. **Thoressa evershedi** Evans
(not included in W-B)

EVERSHED'S ACE has been recorded from the Palnis, Nilgiris and Annamalais and is endemic to South India. I know nothing about it though doubtless it is limited to wet lowland evergreen forest like the others of its genus.

262. **Iambrix salsala luteipennis** Plötz

The CHESTNUT BOB is often a common butterfly in the denser forest types at lower and middle levels and deep inside the forest it is sometimes the only skipper present. It usually frequents shady places but will often sun itself in shafts of sunlight when not searching out the minute flowers in small clearings. The flight is rarely more than a few centimetres above the ground. The species is one of the few skippers consistently to use only four of its legs for perching or walking, though I have seen this also in *Suniana sunia*s Waterhouse in Papua New Guinea. For what purpose the front legs are being kept in reserve I have been unable to discover. The species is found in Sri Lanka and in South India, then from Nepal east to Hong Kong and southern China and south to Sundaland.

263. **Psolos fuligo subfasciatus** Moore

The COON is a very unusual skipper found in the wetter lowland forests of the western slopes. It is not normally very common, but towards the end of the monsoon numbers increase. The flight is very slow for a skipper and the wings large in relation to body size. The wings are an almost unmarked dark brown. When sitting on a green leaf the peculiar downcurved shape of the forewings may be noticed. It is so pronounced that the tips of the front wings are several millimetres apart in the normal resting posture. The Western Ghats population is strongly disjunct; the species recurs from northeastern India to the Philippines, Sulawesi and Sundaland.

264. **Notocrypta paralysos alysia** Evans

The COMMON BANDED DEMON is one of two very similar species which are almost jet black with a white forewing band. The present species lacks white apical spots on the forewings which are prominent in the following species. In the Nilgiris it seems to be limited to the lowland evergreen forests of the western slopes and I have only collected it in the Nadgani Ghat area in moderate numbers. Elsewhere in Asia it may be very common. Usually it skulks about in dark undergrowth but often ventures out to feed on flowers, not infrequently on overcast days. The flight is almost as fast as that of the *Celaenorrhinus* which, because of the white forewing bands, it greatly resembles on the wing. The range covers Sri Lanka and the Western Ghats, then from Mussoorie east to the Philippines, Sulawesi and the Lesser Sunda Islands.

265. **Notocrypta curvifascia curvifascia** Felder & Felder

The RESTRICTED DEMON seems to be a butterfly mainly of the moist deciduous forests of the Wynaad where I have taken my only Nilgiri specimen, though Gordon Thompson collected one at Kallar in September 1986, the only one ever recorded for the southern slopes of either of the two *Notocrypta.* My belief that it is a species of the moist-deciduous forest is bolstered by the fact that I found it quite common under such conditions in the Biligiriranga Mountains together with *Celaenorrhinus ruficornis.* It, too, is found in both Sri Lanka and southern India, then from Mussoorie to South China and Sundaland.

266. **Udaspes folus** Cramer

The GRASS DEMON is a very distinctive butterfly that is taxonomically close to the *Notocrypta.* The big white patch on the disc of the hindwing upperside is enough to tell it from any other South Indian skipper. While it may turn up anywhere in the Nilgiris, it seems to be mostly rather scarce and unpredictable. From late August through October 1986 I regularly had specimens pass through my Kotagiri garden at high speed in what looked like a dispersal movement of some sort, but which was not correlated with the migrations that were taking place at the time. It coincided with the first captures of the butterfly at Kallar. I have also taken it at the very top of the Biligirirangas near Honametti Estate. It is a rare butterfly in Sri Lanka from where it is found throughout the Oriental and Australian regions without displaying geographical variation. It is generally rather uncommon everywhere and during several visits to many Asian countries I have only secured one specimen in Malaysia apart from my Indian ones.

267. **Arnetta mercara** Evans
(*Astictopterus jama*)

The COORG FOREST HOPPER is rather similar to *Psolos fuligo* but may be immediately distinguished through the presence of three small white apical spots on the forewings that are always missing in the latter. I have never come across it in the Nilgiris but it seems that it may sometimes be found in some numbers on the Nadgani Ghat which does not surprise me. Generally it is not a common species and it is endemic to the Western Ghats.

268. **Arnetta vindhiana nilgiriana** Moore

The VINDHYAN BOB is endemic to southern and central India where it appears to frequent wet grasslands at lower levels in most type of terrain. Ssp. *nilgiriana* represents a southern group of the species merging with the nominate subspecies in the Nilgiri Wynaad. It seems to be found under a variety of climatic conditions and presumably the exact conditions of the wet grassland is of more importance than the macroclimate. Certainly it is a most unusual distribution pattern. Hampson considered it common and Wynter-Blyth collected it on the Nadgani Ghat in October. I have never come across it in the Nilgiris but have a few from Sholayar in the Annamalais.

269. **Suastus gremius gremius** Fabricius

The INDIAN PALM BOB is surprisingly rare in the Nilgiris not least when it is considered how many palms there are in Mettupalayam/

Kallar and along the rice growing areas of the western slopes. I have only small numbers from Kallar and from the Nadgani Ghat agricultural areas, and I doubt if it ascends the ghats to any great extent. According to Wynter-Blyth it comes to both water and bird droppings, but I only know it as avid visitor to Lantana flowers. When the female lays eggs she lands on a palm frond, walks backwards for a distance equal to two to four times her own length, and then either flies off or deposits a single, large brick-red egg. This colour is unusual but I have little doubt it is meant to mimic the dark, damaged spots often found on palm leaves. The range covers Sri Lanka, India, Bangladesh, Burma, Thailand, Indo-China, Taiwan and parts of southern China.

270. **Suastus minuta bipunctus** Swinhoe
(not included by W-B)

The SMALL PALM BOB is very similar to the preceding species but on average a little smaller and with the black hindwing underside spots somewhat differently disposed. There are a few old records from the Nadgani Ghat area but I know nothing of it at all. It is found in Sri Lanka and South India, then from Sikkim east to the Philippines and Java, apparently bypassing Sundaland proper, being absent from Malaysia and Sumatra. The distribution indicates that it inhabits rather more mesic habitats than its more widespread congener.

271. **Cupitha purreea** Moore

The WAX DART is so named because the male has a prominent brand on the hindwing upperside which contains a waxy substance. The species can be recognised at a glance, in South India at least, by its wholly immaculate yellow underside. It is quite a pretty little butterfly but it is also a scarce one. I have taken five specimens only, at Kallar, always sitting on green leaves in the morning before 10.00. I have never observed it flying or doing anything else, but every now and then, suddenly one will be sitting in exactly the same posture as the last one. The species is of particular interest inasmuch as the larval food plants are *Terminalia* and *Combretum*; it is the only member of the Hesperiinae to have returned secondarily to dicotyledonous food plants. The range is wide, covering practically the entire Oriental region, though not Sri Lanka and peninsular India. It is everywhere rare. The genus is monobasic.

272. **Baracus vittatus** Felder & Felder

The HEDGE HOPPER is a very plastic species in a monobasic genus. The nominate subspecies from Sri Lanka is very light greenish white above, three Indian subspecies are very different. Ssp. *subditus* Moore (Palnis, Travancore and Nilgiris) intergrades with ssp. *hampsoni* Elwes & Edwards in our area, extending north to Kanara. Ssp *gotha* Evans occurs in the Annamalais. The main differences lie in the patterns of the underside. A separate subspecies is found from Sikkim to Yunan in China. I have not come across the species though it has been recorded as not rare in the Nilgiris by earlier authors.

273. **Hyarotis adrastus praba** Moore

The TREE FLITTER is a readily identified medium-sized skipper that is relatively scarce in evergreen forest at low and medium levels. I have only seen it three times; once at Glenburn (12.vi), and twice at Kallar (19.viii & 30.ix), one of which was taken by Gordon Thompson. Hampson found it rare on the northern slopes, but says that it is common on the southern slopes. He must have run into some sort of mass emergence, especially since Wynter-Blyth did not see any. I am quite convinced that it is scarce and Bell, writing of

Kanara, commented that it was hardly ever seen though he was able to find the caterpillar quite often. The distribution covers Sri Lanka and South India, then from Himachal to Hong Kong and Sundaland. It seems likely that the rare *Hyarotis microstictum coorga* Evans will also turn up in the Nilgiris.

274. **Quedara basiflava** de Nicéville
(not mentioned by Wynter-Blyth)

The YELLOW BASE TREE FLITTER is a rare endemic South Indian butterfly which has been recorded by Hampson for the Nadgani Ghat area. It is a most distinctive species with the bases of the hindwing underside liberally marked with egg-yolk yellow. Apart from the fact that it is rare and that it is almost certainly limited to the wettest evergreen forests, I know nothing of this insect. Another rare skipper that could occur under similar conditions is *Plastingia sala* Hewitson.

275. **Gangara thyrsis thyrsis** Fabricius

The GIANT REDEYE is the largest skipper in the Nilgiris and it seems to be quite rare. This was Hampson's opinion and Wynter-Blyth caught one only at Kallar. On my first collecting trip in the Nilgiris (14.iv) I collected a fresh male with my fingers off the nose of Gordon Thompson. A week later I found several larvae and pupae on a palm in the compound of Mr Dharman near Glenburn, several of which hatched in Kotagiri. Since then I never saw it again. Given the profusion of palms in the Kallar and Mettupalayam areas its rarity is curious, not least since it is sometimes quite common and attracted to light at night. The absence of its banana eating relative *Erionota thrax* Hübner is also puzzling. The species is found practically throughout the Oriental region.

276. **Matapa aria** Moore

The COMMON REDEYE is not rare in thick lowland forest with bamboo, out of which it seldom ventures. It is best caught early in the morning (sometimes even before 07.00) when it suns itself on green leaves along forest paths, very occasionally visiting flowers. I have never seen it on damp patches. Later in the day it disappears completely and is impossible to procure. The red eyes will, even at a distance, tell it apart from the somewhat similar members of the *Baoris* and *Caltoris*. It belongs to a genus that is centred on Sundaland and is the only one to be found in our area. The genus was recently monographed by de Jong (1983). The range covers Sri Lanka and India to South China and the Philippines, Sundaland to Java and Borneo, but not Sulawesi, where similar species occur. It is the most widely distributed of all the *Matapa.*

277. **Taractrocera maevius sagara** Moore

The COMMON GRASS DART in my experience is scarce in the Nilgiris and I have but one specimen from plantations near Mettupalayam. Hampson collected only four, while Wynter-Blyth considered it to be not rare at Kallar where I never saw it. The species is reputed to be very local and probably I never found just the right spots. The habitat seems to be grassy places under a variety of macroclimatic conditions from the plains up to at least 1600 m, though in South India it appears to be more of a plains species. The genus seems to be very fond of flowers. The species is common in Sri Lanka and is endemic to Sri Lanka, India, Burma and Thailand.

278. **Taractrocera ceramas ceramas** Hewitson

The TAMIL GRASS DART is a conspicuous insect of open grasslands at all levels and in most types of habitat, though chiefly the montane grasslands, in open spaces of moist-deciduous forest, and along grassy verges of forest roads in the wettest parts of the lowland forests. Each and every population of this butterfly seems to be special in one way or another. Typical *ceramas* is from the high level grasslands and is small and pale. Lowland specimens, often referred to as ssp. *lynx* Möschler, are usually larger and more luxuriant. According to Evans (1949) the taxon *lynx* is not subspecifically valid, while ssp. *media* from Kanara, ssp. *oberthueri* from the Annamalai, and ssp. *nicevillei* from the Bombay Presidency are. I have personally only found small and weakly coloured nominate *ceramas* in the Nilgiris, at high altitudes near Mukurti and Avalanche, and some larger and more luxuriant forms at Nadgani and the Nilgiri Wynaad approaching *media*. In the Biligiriranga Mountains I collected a large series of large specimens from 1300 to 1900 m which match none of my Nilgiri ones. I doubt that the very real variation from population to population of this butterfly in South India can be described in conventional subspecific terms. In addition to South India the species also occurs from Manipur to southern China.

279. **Oriens concinna** Elwes & Edwards

The TAMIL DARTLET is a great rarity in the Nilgiris, being confined to the upper subtropical and montane forests, where it is very difficult to find. Wynter-Blyth caught two below Coonoor. I have three from the Longwood Shola near Kotagiri (20.iv, 23.viii, and 11.x) one collected by Gordon Thompson. This is the fruit of more than twenty visits to this lovely forest. The species is endemic to the mountains of South India, south of the main Western Ghats which do not appear to be high enough.

280. **Oriens goloides** Moore
(*Oriens gola*)

The INDIAN DARTLET resembles the members of the next genus, but may readily be recognised by the layout of the upperside orange markings of the forewings where the discal band touches those of the cell. According to Wynter-Blyth it is sometimes common on the Nadgani Ghat, but I have only found it occasionally at Kallar and Nadgani. It is found in evergreen forest of the tropical and subtropical types, occasionally being found up to 1600 m or so, above which it is replaced by the preceding species. In habits it is similar to the *Potanthus*, spending most of its time sitting on green leaves, occasionally coming to flowers and only very rarely to water. It is found in Sri Lanka and South India, then from Kumaon east to Malaysia, other species representing the genus further into the Oriental region.

The genus **Potanthus**

The genus *Potanthus* contains five species that occur in South India according to Evans (1949). They are very difficult to deal with. No data from before Evans' book are correct and in most cases impossible subsequently to verify. Furthermore I should not be at all surprised if the classification of the taxa recognised by Evans in South India will eventually be found to be in need of revision. Unfortunately none of the species is particularly common, and I do not have a very large material on which to base personal study of the South Indian taxa. I shall list the taxa recognised as South Indian by Evans as valid for the Nilgiris even in the cases where I have not seen Nilgiri material. They are all certain to occur. Firm identifications need genitalia dissection, not least since there is also seasonal variation. The 'majority of characters' indications below might serve to place individual specimens in the correct species, but it really is impossible to be certain except when a typical specimen is compared with a correctly identified comparative series, and the genitalia examined if there is the least doubt. Females are even more difficult than the males.

281. **Potanthus pallida** Evans
(*Padraona* sp.)

The PALLID DART is rare in South India since Evans lists only six specimens from the Nilgiris. The bands are straw yellow like in *P. pseudomaesa* but the wings are not so strongly produced as in the other species. Given the amount of material available to Evans it is necessary to assume that it is genuinely absent from the Western Ghats proper, which would indicate that it is something of montane species. The range covers Sri Lanka and South India, then from Simla to Indo-China and Yunan.

282. **Potanthus pseudomaesa pseudomaesa** Moore
(*Padraona* sp.)

The PSEUDOMAESA DART is similar to the preceding species with straw yellow markings, but the wings are shaped like the others of the genus. The species seems to be considerably more common. I have specimens from Glenburn, Nadgani and the Biligiriranga Mountains. In most cases small series were taken in sunny forest glades and along paths. The range covers Sri Lanka, South to central India, Mt. Abu and then from Kashmir to Hong Kong.

283. **Potanthus confucius diana** Evans
(*Padraona* sp.)

The CONFUCIAN DART is the smallest of the South Indian species, the markings of the upperside are a much darker orange than in the two preceding species, and the brand broader than in the larger *P. palnia*. Judging from the limited series available in London it is not a common South Indian butterfly. My own single specimen is from the Nadgani Ghat; it is much smaller than any other of the genus in my collection. The distribution covers Sri Lanka, South India, Madhya Pradesh, Nepal to Japan, the Philippines and Sundaland.

284. **Potanthus pava pava** Fruhstofer
(*Padraona* sp.)

The PAVA DART has relatively broad bands of a golden orange that contrasts strongly with the pale straw of the Pallid and Pseudomaesa Darts. The veins are less marked where they cross the bands than is normal in the genus. The forewing markings of 4 and 5 are well joined with the main discal band and is always in contact with the three apical spots. The species does not appear to be at all common in southern India. I have a single specimen from Mukkali as well as a fair series from the Biligiriranga Mountains where they were caught in moist-deciduous forest. The species is found in South India, then from Himachal east to most of the Oriental region.

285. **Potanthus palnia** Evans
(*Padraona* sp.)

The PALNI DART was described from the Palnis and appears to be the most common of the South Indian *Potanthus.* The bands are narrow and of a deep orange-hue. I have specimens from Glenburn, Kallar, Wenlock Bridge, and Mukkali as well as from the Biligiriranga Mountains. The range covers southern India, then from Sikkim to Burma and Thailand. It is said to recur on Sumatra though absent from Malaysia; the Sumatran form is almost certainly a good species.

286. **Telicota colon colon** Fabricius
(*Astychas augias & pythias*)

The two *Telicota* are like scaled up members of the previous genus, but are more powerful insects of more open country. The PALE PALM DART can usually, but not invariably, be told from the next by the fact that the forewing veins are yellow right out to the edge of the wing, but there is individual and seasonal variation in both of the species. Both are common in open country near forest and do not differ much in habits, though perhaps the present species will be found in slightly more open country than the next. The range covers practically the entire Oriental region deep into the Pacific and the Australian region.

287. **Telicota ancilla bambusae** Moore
(*Astychas augias* & *pythias*)

Apart from living in closer proximity to forest and perhaps being found under slightly more mesic minimum conditions, there is no difference between the DARK PALM DART and the previous species in range and behaviour, except that it is missing in some parts of the drier NW India where the other occurs. Both species are fond of flowers, come to bird droppings, but rarely or never to water.

288. **Parnara naso bada** Moore
(not included in W-B)

The AFRICAN STRAIGHT SWIFT is readily recognisable from the other small skippers of the group in South India by the lack of cell spots in both sexes and by the lack of a spot in space 1b of the male. Wynter-Blyth expresses surprise that he did catch the very similar *P. guttatus mangala* Moore, but that species does not occur in South India at all. I have found the species not too uncommon mainly at lower levels and in the subtropical zone, but it will probably turn up in most habitats from time to time. It is one of the few skippers to be Palaetropical, being widely distributed in Africa and recurring from Sri Lanka and India to the Philippines, Borneo, Sulawesi, Sumatra and Java, and then Queensland, apparently bypassing New Guinea.

289. **Borbo cinnara** Wallengren
(*Baoris zelleri*)

The RICE SWIFT is a relatively common butterfly in the Nilgiris, being found in most types of terrain, but rarely on the plateau proper. I never found it as abundant as Wynter-Blyth seems to imply in his Nilgiri paper. It is most usually caught at low flowers, sometimes on Lantana. The name *zelleri* Lederer has often been used in conjunction with this butterfly but this is quite mistaken since this name applies to a form of the Afrotropical *B. borbonica* which has no link to the Oriental region. The species ranges throughout the Oriental region in almost all ecological zones, extending to New Guinea, Australia and the New Hebrides.

290. **Borbo bevani** Moore
(*Baoris bevani*)

BEVAN'S SWIFT has the wings, especially the hindwings, so broad that it cannot be mistaken for *B. cinnara*. The usual spotting is sometimes nearly obsolete. Only Hampson has recorded it from the Nilgiris where it seems to be scarce, and I have never found it common anywhere. From South India I have a few specimens from the Biligiriranga Mountains. The range is from most of India (but not Sri Lanka) to much of the rest of the Oriental region, but not Malaysia, Borneo and New Guinea, then again in NE Australia.

291. **Pelopidas agna agna** Moore
(not included in W-B)

The DARK BRANDED SWIFT is very similar to *Pelopidas mathias*, a common species generally found in more open country than the present one. It is a small species with less developed hyaline markings, and normally the spots on the underside hindwings are less prominent than in *mathias*. On close examination the brand will be found to be placed slightly differently. I have not found it particularly common but most visits to the tropical and subtropical evergreen forests will turn up a specimen or two. It is fond of Lantana flowers. The range covers virtually all of the Oriental region.

292. **Pelopidas subochracea subochracea** Moore
(*Baoris sinensis*)

The LARGE BRANDED SWIFT is an altogether more impressive insect than the other South Indian members of the genus *Pelopidas*. The white forewing brand in the male is prominent and the deep ochre hindwing underside has prominent white spots in interspaces 2, 3 and 6, and prominently in the cell. It seems to be rare in the Nilgiris, Wynter-Blyth having taken one only at Kallar. I never saw it in the Nilgiris, but I have one from Sholayar in the Annamalais. The range covers Sri Lanka and South India, then from Sikkim east to Thailand, Yunan and Hainan.

293. **Pelopidas mathias mathias** Fabricius
(*Baoris mathias*)

The SMALL BRANDED SWIFT is a dry zone species that has been the subject of much confusion with *P. agna*. I never saw it till October 1986 after having spent six months in the area. Then a small skipper participated in the migrations and on a visit to Masinagudi I found large numbers of this species at flowers and at water. It would appear that a few migrants had been responsible for the production of a large brood which proceeded to move towards the south on hatching. I had prospected this locality on numerous occasions during the preceding months without seeing the species. The distribution is vast, covering all of Africa. much of Arabia and the whole of the Oriental region, with extensions to the temperate zone in Asia as well as to New Guinea.

294. **Pelopidas conjuncta narooa** Moore
(*Baoris conjuncta*)

The CONJOINED SWIFT is a large species with male stigma on the forewings. The markings are a pale yellow and not the milky white of the other species of the genus. The hindwing underside usually carries a complete complement of white spots and those of at least spaces 2 and 3 are usually present on the upperside as well. Though Wynter-Blyth records it from Ketti, Kallar, Gudalur and Nadgani I have failed to find it. The distribution covers Sri Lanka and South India, from there to Sikkim, Assam, east to southern China, the Philippines, Borneo and Java.

295. **Polytremis lubricans lubricans** Herrich-Schäffer
(*Baoris contigua*)

The CONTIGUOUS SWIFT is so called because the two cell spots are almost always merged. The hyaline spotting is yellowish and the ground colour has a distinctly chestnut tinge. All told the species has a different 'feel' from the related species. It seems to be very scarce in the Nilgiris. Wynter-Blyth took one on the Nadgani Ghat and I have a single specimen from the bottom of the Ghat which was not visited by him because of war-time petrol rationing. My specimen is from 20.vii.1986. The species is found on the Western Ghats, then from Kumaon east to southern China and through Sundaland to Timor and the Sula Islands.

296. **Baoris farri farri** Moore

The PAINTBRUSH SWIFTS constitute a complex of three species whose males have a dense brush of androconial scales on the upper hindwings. This species is the South Indian representative and the male is unlike any other species in the area because of the brush. The female is rather like that sex of *Caltoris canaraica*, but she never has light spots on the hindwing underside like the latter. It is relatively rare and seems to be limited to the wettest lowland evergreen forests. I know of records only from the Nadgani Ghat where I have especially found it in the early mornings sitting on green leaves along jungle paths, but on drizzly days it may be found feeding from Lantana as well. By 10.30 they disappeared completely. On one or two occasions I have caught males on fresh buffalo dung. The species is found in India and then east to Hong Kong, Malaysia and Sumatra. The closely related *B. penicillata* Moore is found on Sri Lanka, recurring from Sikkim east without being found in South India. Two other species of the genus are found from NE India to Sundaland.

297. **Caltoris kumara kumara** Moore
(*Baoris kumara*)

The BLANK SWIFT is a large, compact insect without hyaline spots in the forewing cell. Wynter-Blyth recorded it from a number of localities including Ketti (common), Kallar, Gudalur and Nadgani which is surprising to me since I have found just a few in the wettest Nadgani habitats. This might be because his records were mainly from October to January, a period of the year that I did not cover. The species is found in Sri Lanka and South India, then from Sikkim to Thailand, Indo-China and Java, but not Malaysia and Sumatra.

298. **Caltoris canaraica** Moore
(*Baoris canaraica*)

The KANARA SWIFT is a rather rare South Indian endemic. It is very like *Caltoris kumara*, though a bit smaller, but both sexes have two clear hyaline spots in the forewing cell. I have found it quite numerous on a single occasion on the Nadgani Ghat (mid July), in small numbers on a previous occasion, and once near Mukkali at the foot of the Silent Valley system. These seem to be the only Nilgiri records. It is probably limited to the wetter lowland evergreen forest and in my experience it is best caught very early in the morning, as early as 07.00.

299. **Caltoris philippina philippina** Herrich-Schäffer
(*Baoris philippina*)

The PHILIPPINE SWIFT definitely occurs in the Nilgiris, but I have not collected it and can say nothing about it except that it is probably mainly found in evergreen forests, including the subtropical level. It is widely distributed from Sri Lanka and South India, via Sikkim and Assam to the Oriental region, New Guinea and some of the Pacific islands.

SOUTH INDIAN BUTTERFLIES NOT YET RECORDED FROM THE NILGIRIS

Azanus uranus Butler — widely distributed in India and almost certain to occur in the dry zone lowland habitats somewhere in the Nilgiris area.

Arhopala bazaloides Hewitson — recorded from Kanara and almost certainly to be found somewhere in lowland evergreen forest.

Apharitis lilacinus Moore — possibly found in the dry zone habitat since known from Karnataka.

Parantirrhoea marshalli Wood-Mason — an endemic species in a monobasic genus and one of South India's most interesting endemics, known from Coorg and Travancore. There are two in the British Museum (Natural History) marked 'Coonoor, Manders, 11.1910' in the same handwriting. The species is a lowland one. They cannot be from Coonoor, but I would not be surprised to find it on the western slopes.

Mycalesis mamerta davidsoni Moore — recorded from Trichy and possible in the Nilgiris area..

Mycalesis oculus Marshall — limited to the hills south of the Palghat Gap. Will not be found in the Nilgiris.

Ypthima ypthimoides Moore — as above.

Pantoporia sandaka davidsoni Eliot — known from the Coorg area and probable in the Nilgiris.

Phalanta alcippe Cramer — known from Coorg, very locally. May just possibly occur in the Nilgiris.

Bibasis gomata kanara Evans — known from Kanara.

Hasora vitta indica Evans — known from Kanara. No Nilgiri records or specimens in BM(NH).

Caprona agama agama Moore — mentioned by Evans (1949) from the Palnis and Madurai.

Aeromachus dubius dubius Elwes & Edwards — should occur in the Nilgiris as known from both north and south thereof.

Plastingia sala Hewitson — known from Kanara, might occur in the Nilgiris.

Hyarotis microstictum coorga Evans — known from Kanara and probable in the Nilgiris from where it has been recorded, but possibly in error.

TENTATIVE CONCLUSIONS

It is my intention to analyse the data presented in this paper in a more detailed fashion in order to study the ecological and zoogeographical composition of the Nilgiri butterfly fauna, the degree of endemism and other factors. This has not yet been done, but it seems appropriate to end the paper with some tentative conclusions that are unlikely to change in the face of a more detailed analytical treatment.

The first conclusion that can be drawn is that the Nilgiri fauna, with just 300 species, is rich, varied and very interesting. There is probably no other area of similar size in India that has that many species, partly because those areas which have true rainforest will not simultaneously house the montane and temperate element that is found in the high Nilgiris. Sri Lanka, further south, has only about 240 species.

The second conclusion that can be drawn is that the Nilgiri mountains contain practically all the species ever recorded from anywhere in southern India. Only a dozen or so potential species remain unrecorded. Possibly a few of these will turn out to be limited to the wettest parts of the Kanara Ghats, but most will eventually be found also in the Nilgiris.

A third conclusion is therefore that the faunal composition of the wetter South Indian mountains probably does not differ much from one to another. So far only two species are known to be limited to the mountains south of the Palghat Gap.

By far the richest habitat in terms of numbers of species is the lowland rainforest, closely followed by the wet evergreen forests. The butterflies of these zones are mainly Oriental and it is notable that those limited to the rainforests tend to have affinities to the Sundaland fauna rather than to the Indo-Chinese/Thai. Most of the specialities of these two zones have strongly disjunct distributions, being absent from peninsular India.

The lowland mixed deciduous forest is also quite rich and is especially interesting for being the headquarters of a number of species that are endemic to the Indian peninsula (and sometimes Sri Lanka). The drier formations contain mainly widespread Oriental and Palaeotropical species, but there is a decided admixture of Afrotropical and Eremic elements (details about these will be found in Larsen, 1984).

The subtropical evergreen forests contain a small number of species that seem to be centered on this zone. They will usually be the type of species that are also found in the subtropical zone of the Himalaya east to southern China, but not infrequently without Sundaland connections.

The plateau has a limited number of species of varied composition. The most noticeable are the disjunct Palaearctic elements, and the Oriental montane species. They are not many, but very prominent in the natural highland habitats. A number of widespread genera show secondary specialisation to the South Indian mountains and have developed local endemics. Finally there are many of the widespread and hardy Oriental and Palaeotropical species.

Zoogeographically South India is very much a part of the Oriental Region and virtually the entire fauna is Oriental of origin. Most of the endemic species belong to genera that have their centres of diversity elsewhere in the Oriental Region. The score or so Palaeotropical species are represented virtually in full. The eremic, desert-adapted species are again few, mainly limited to the driest tracts and not much in evidence elsewhere. The few Afrotropical species are limited to the same habitats. The Palaearctic butterflies are few in number, though rather prominent in the depauperate butterfly fauna of the plateau proper.

The level of endemicity is both low and at low taxonomic levels, even when the whole of peninsular India, including Burma, is taken into account. Strict endemics at generic level are *Parantirrhoea,* which has not yet been found in the Nilgiris, and *Sovia* which is closely related to the *Halpe.* Wider endemics are *Talicada, Rathinda* and *Zezius,* and perhaps one or two others. The number of more or less endemic species is also modest in relation to the total fauna, not least when it is taken into account that so many of the species are strongly disjunct, being isolated in the South Indian wet zones. The bulk of the endemics are isolated species in genera that have their centres of diversity elsewhere in the Oriental region.

There is much similarity between the fauna of South India and Sri Lanka, but there are also surprising differences. A considerable number of South Indian butterflies that one would have expected on Sri Lanka do not occur, while Sri Lanka has a number of endemics and a number of disjunct species not occurring in South India. At first sight the differences appear larger than one would have expected a *priori.* I hope to analyse this matter in a subsequent paper.

The initial impression that is gained is consistent with the conclusions of Holloway (1974), namely that if India had its own butterfly fauna when it merged with the rest of Asia after rafting from Gondwanaland, then all traces of this fauna has been lost. Otherwise, one would have to postulate both that India had been overwhelmingly responsible for populating the remainder of the Oriental region, and that in most cases the genera and species diverged far from the Gondwanan ancestors. Again I plan to look further into this issue, but at present it appears that South India has a fauna that is derived from a series of relatively recent contacts with neighbouring faunal regions, with some modest degree of subsequent speciation in isolation.

Finally it is a pleasure to say that during seven months in the Nilgiris it was possible to collect the bulk of all the species that have ever been recorded from there. A comparison with earlier lists shows that there has been no significant depletion of genetic resources in butterflies, and I believe them to be a good indicator for general ecological conditions. However, habitats have been much shrunk. They are today just adequate and will, on the whole, not accept further large scale encroachment. That largest of all indicators of environmental health, the Indian Elephant, in some parts of the Nilgiris has lost its normal migration routes to human interference. Future conservation efforts must not only be concerned with establishing well-managed reserves in all habitat types. They must also conserve the necessary corridors to permit genetic flow between the various parts of the Western Ghats system as a whole. In practical terms this means that the whole area of Tamil Nadu and Kerala now forested should not be allowed to shrink any further. Nature conservation in the more narrow sense apart, there is increasing evidence that further deforestation of the Western Ghats system will lead to problems on a macro-ecological level in terms of water supply, erosion, and possibly even long term climatic effects.

As long ago as 1911 the crusty old hunter, F. W. F. Fletcher wrote of the Nilgiris: 'But over the portals of modern Ootacamund, with its railway and its motor cars and all the other things that proclaim the march of progress, let there be written: *Sic transit gloria* (*Ootaca*) *mundi*'.

Seventy years on the picture is still not quite that bad. I, for one, hope, and trust, that India is one of the countries that can mobilise the political will and the administrative skill to safeguard what is left of a priceless natural environment.

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ON THE FISH FAUNA OF KEOLADEO NATIONAL PARK, BHARATPUR (RAJASTHAN)[1]

C. R. AJITH KUMAR AND V. S. VIJAYAN[2]

(*With a text-figure*)

INTRODUCTION

One of the major attractions of Keoladeo National Park, a world heritage site, is its rookeries and heronries huddled on babul trees (*Acacia nilotica*) in the semi-aquatic areas of the Park. Although the importance of fish to these colonies of fish eating birds was emphasized by Salim Ali (1953) about three decades ago, no concerted effort has been made hitherto to study the fish fauna of the Park in detail. Saxena (1975), Datta and Majumdar (1970), and Mahajan (1980) have reported the faunal elements but their study was seasonal and hence incomplete.

The present report covers a survey of the fish fauna of Keoladeo National Park, conducted between 1982 and 1985 as part of a long-term ecological study of the Keoladeo National Park by the Bombay Natural History Society. Altogether 40 species have been recorded. Some species recorded by earlier workers were not seen during the present study while some new species have been added both to the fish fauna of Keoladeo National Park and to that of Rajasthan. All the species recorded so far by various workers have been included in the checklist.

KEOLADEO NATIONAL PARK

Keoladeo National Park (27° 7.6′ to 27° 12.2′ N and 77° 29.5′ to 77° 33.9′E) is a tiny wetland surrounded by villages, about 3 km. from Bharatpur town. It is halfway (180 km.) between Jaipur and Delhi and is about 58 km. south of Agra.

The Park is 28.5 sq. km., out of which the aquatic area is only 8.5 sq. km. The entire aquatic area is divided into various compartments by means of bunds, and the water level in each compartment is regulated through sluice gates. The maximum water depth is up to two metres. During summer the Park dries up, leaving only a few isolated pools (for more details, see Salim Ali & Vijayan 1983).

Water temperature varied from 12° to 32°C during the study period, the maximum being in May and the minimum in January. Annual rainfall during 1982 to 1985 was 27 to 52 cm., received mainly during July to August.

The aquatic vegetation of the area consists mainly of: (1) Submerged vegetation, namely *Hydrilla verticellata*, *Ceratophyllum* sp., *Najas minor*; (2) Floating vegetation, namely *Nymphaea nouchali*, *N. stellata*, *Nymphoides cristatum*, *N. indicum*, *Ipomoea aquatica*, *Azolla bipinnata*, *Lemna paucicostata*, *Wolffia arrhiza*, and (3) Emergent vegetation, such as *Paspalum distichum*, *Elaeocharis plantaginea*, *Sporobolus helvolus* and *Cyperus alopecuroides*.

Water source to the Park.

A consideration of the water source to the Park, its geographic position, and the age old management practice will give an insight into the fish fauna of the Park.

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The Park is situated at the confluence of two non-perennial rivers—Gambir and Banganga; the former originates from the Karoli hills of Sawai Madhopur, flows about 280 km. before reaching Bharatpur and passes through Bharatpur to join Yamuna on the east. River Banganga originates near Manoharpur (near Jaipur) about 64 km. northwest of Jamwa Ramgarh, runs about 241 km. before terminating at Mekpur head, 18 km. short of Bharatpur (Fig. 1).

Water from Gambir and Banganga is drawn through Pichuna canal and Uchain canal respectively and empties into a temporary reservoir, Ajanbund, situated approximately 500 metres south of the Park. From here the water is let into the Park through Ghana canal. Enormous number of fish fry also enter the Park through these waters. Thus the aquatic ecosystem of the Park is an open system, having connections with the aforesaid two rivers which finally join the perennial Yamuna. The fish fauna of the Park also represents, partially at least, the fauna of all these waters. Even though the rivers are non-perennial, permanent large water bodies such as Jamwa Ramgarh Tal, Bund Bareta, Jagur Tal and Kalako Bund are connected to either Banganga or Gambir, forming a common water system.

Methods of collection.

The following methods were used for sampling the fish fauna:

I. *Gill nets*: Gill nets of the size 11 × 1.20 m. with mesh sizes varying from 3.5 to 6.5 cm. were used to collect fish from open water where submerged vegetation may or may not be present.

II. *Traps*: Traps of two sizes, 35 × 30 × 40 cm. and 25 × 35 × 35 cm, made of split bamboo were employed to sample fishes from areas where thick vegetation occurred.

III. *Cast net*: Was used in open water and in pools.

IV. *Fry sampling net*: The bridge over Ghana canal near 'Chital van' has five pillars. The space between the adjacent pillars was blocked with a square net made of mosquito netting to sample the fish fry entering the Park from Ajanbund. Each net was of 150 × 150 cm.

RESULT

Fish fauna of the Park

All the 50 species recorded so far are listed below, following the classification adopted by Jayaram (1981).

I Order : CLUPEIFORMES
Family (i): CLUPEIDAE
Genus (1): *Gadusia* Fowler
1. **Gadusia chapra** (Hamilton)

II Order : OSTEOGLOSSIFORMES
Family (ii): NOTOPTERIDAE
Genus (2): *Notopterus* Lacépède
2. **Notopterus notopterus** (Pallas)

***3. **Notopterus chitala** (Hamilton)

III Order : CYPRINIFORMES
Family (iii): CYPRINIDAE
Genus (3): *Oxygaster* van Hasselt
4. **Oxygaster bacaila** (Hamilton)

Genus (4): *Danio* Hamilton
****5. **Danio** sp.

Genus (5): *Chela* Hamilton
****6. **Chela** sp.

Genus (6): *Esomus* Swainson
7. **Esomus danricus** (Hamilton)

Genus (7): *Labeo* Cuvier
8. **Labeo bata (Hamilton)
9. **Labeo calbasu** (Hamilton)

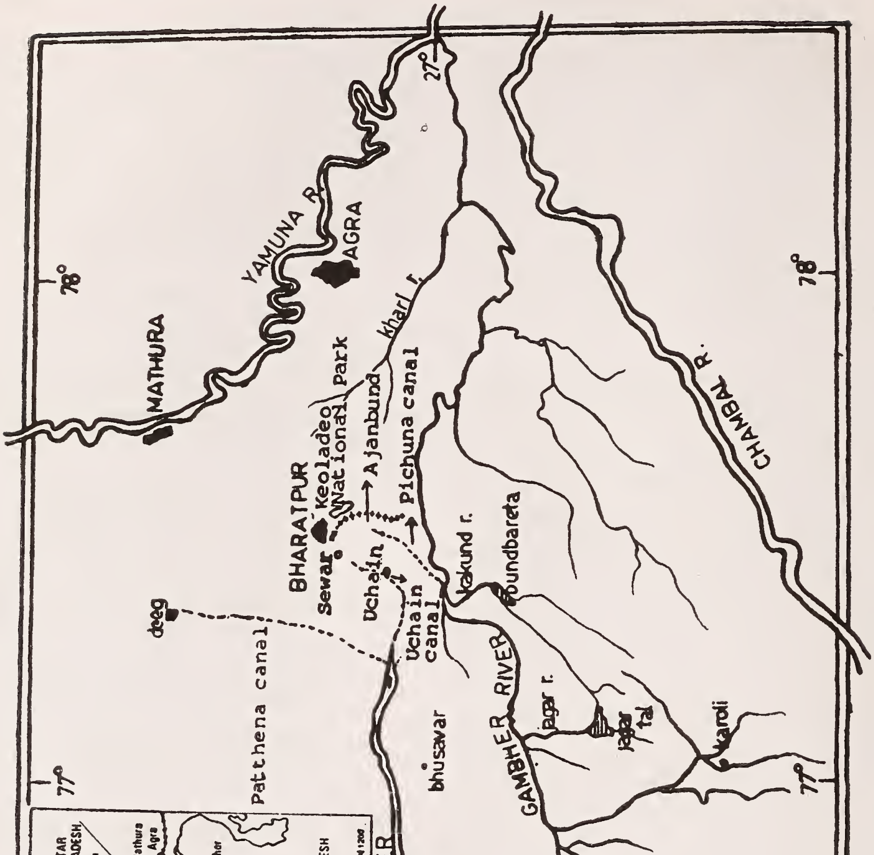
YAMUNA R.
AGRA
MATHURA
78°
27°
BHARATPUR
Keoladeo National Park
Sewar
Ajanbund
Pichuna canal
Khari r.
Uchain
Uchain canal
Kakund r.
Bundbareta
deeg
Patthena canal
bhusavar
GAMBHER RIVER
Jagar r.
Jagar tal
Karoli
77°
CHAMBAL R.
BANGANGA RIVER
Sanwar r.
Lalalo r. bund
dosa
Ramgarh tal
Jamwa
JAIPUR
76°
canal
bund
scale 1:1,000,000
RAJASTHAN
BHARATPUR
HARYANA
UTTAR PRADESH
Delhi
Mathura
Agra
Alwar
Jaipur
Ajmer
Sawai Madhopur
Ranthambhor
Kota
Abu Road
GUJARAT
MADHYA PRADESH
Km
0
200

Fig. 1. Banganga and Gambher river system.

10. **Labeo fimbriatus (Bloch)
11. **Labeo gonius** (Hamilton)
12. **Labeo rohita** (Hamilton)

Genus (8): *Amblypharyngodon* Bleeker
13. **Amblypharyngodon mola** (Hamilton)
Genus (9): *Chagunius* H. M. Smith
*14. **Chagunius chagunio** (Hamilton)
Genus (10): *Cirrhinas* Oken
15. **Cirrhinas mrigala** (Hamilton)
16. **Cirrhinas reba** (Hamilton)
Genus (11): *Catla* Valenciennes
17. **Catla catla** (Hamilton)
Genus (12): *Puntius* Hamilton
18. **Puntius sarana** (Hamilton)
19. **Puntius sophore** (Hamilton)
20. **Puntius ticto** (Hamilton)
Genus (13): *Osteobrama* Heckel
21. **Osteobrama cotio** (Hamilton)
Genus (14): *Crossocheilus* van Hasselt
****22. **Crossocheilus latius latius** (Hamilton)
Family (iv): COBITIDAE
Genus (15): *Botia* Gray
****23. **Botia lohachata** Chaudhuri
Genus (16): *Lepidocephalus* Bleeker
Subgenus : *Lepidocephalichthys*
*24. **L. (Lepidocephalichthys) guntea** (Hamilton)
Genus (17): *Noemacheilus* van Hasselt
*25. **Noemacheilus botia** (Hamilton)
*26. **Noemacheilus corica** (Hamilton)

IV Order : SILURIFORMES
Family (v): BAGRIDAE
Genus (18): *Mystus* Scopoli
27. **Mystus cavasius** (Hamilton)
28. **Mystus vittatus** (Bloch)
Genus (19): *Aorichthys* Wu
29. **Aorichthys aor**
30. **Aorichthys seenghala**
Family (vi): SILURIDAE
Genus (20): *Ompok* Lacépède
****31. **Ompok bimaculatus** (Bloch)
Genus (21): *Wallago* Bleeker
32. **Wallago attu** (Schneider)
Family (vii): SCHILBEIDAE
Genus (22): *Clupisoma* Swainson
****33. **Clupisoma garua** (Hamilton)
Genus (23): *Ailia* Gray
****34. **Ailia coila** (Hamilton)
Genus (24): *Pseudeutropius* Bleeker
****35. **Pseudeutropius atherinoides** (Bloch)?
Genus (25): *Eutropiichthys* Bleeker
*36. **Eutropiichthys vacha** (Hamilton)
Family (viii): CLARIIDAE
Genus (26): *Clarias* Scopoli
37. **Clarias batrachus** (Linnaeus)
Family (ix): HETEROPNEUSTIDAE
Genus (27): *Heteropneustes* Müller
38. **Heteropneustes fossilis** (Bloch)
Family (x): SISORIDAE
Genus (28): *Nangra* Day
****39. **Nangra viridescens** (Hamilton)
V Order : ATHERINIFORMES
Family (xi): BELONIDAE
Genus (29): *Xenentodon* Regan
****40. **Xenentodon cancila** Hamilton
VI Order : CHANNIFORMES
Family (xii): CHANNIDAE
Genus (30): *Channa* Scopoli
*41. **Channa gachua** Hamilton
42. **Channa marulius** Hamilton
43. **Channa punctatus** (Bloch)
44. **Channa striatus** (Bloch)
VII Order : PERCIFORMES
Family (xiii): CHANDIDAE
Genus (31): *Chanda* Hamilton

****45. **Chanda nama** (Hamilton)

****46. **Chanda ranga** (Hamilton)

Family (xiv): BELONTIDAE
Genus (32): *Colisa* Cuvier

****47. **Colisa fasciata** (Schneider)

VIII Order : MASTACEMBELIFORMES

Family (xv): MASTACEMBELIDAE
Genus (33): *Mastacembelus* Scopoli

48. **Mastacembelus armatus armatus** (Lacépède)

49. **Mastacembelus pancalus** (Hamilton)
Genus (34): *Macrognathus* Lacépède

50. **Macrognathus aculeatus** (Bloch)

* Recorded only by Mahajan (1980).

** Recorded only by Saxena (1975).

*** Recorded by both Mahajan and Saxena but not during the present study.

**** Recorded only in the present study.

DISCUSSION

This study adds 13 new records to the fish fauna of Keoladeo National Park, making the total, including those recorded by earlier workers, to 50. It is also interesting to note that this tiny wetland has, altogether, added 13 species to the fish fauna of Rajasthan, increasing it to 88; the former record being 75 species (Datta and Majumdar 1970). Out of the 13 species, six, namely *Crossocheilus latius latius, Ailia coila, Nangra viridescens, Clupisoma garua, Pseudeutropius atherinoides* (?) and *Chela* sp. are recorded by us, while four, namely *Noemacheilus corica, Aorichthys aor, Eutropiichthys vacha* and *Macrognathus aculeatus* are by Mahajan (1980), two species, namely *Tor tor* and *Notopterus chitala* are by Moona (1963) and one species, *Clarias batrachus* is by Saxena (1975). None of the six species recorded by us breed inside the Park and were collected when the water entered the Park. Three of them (*Crossocheilus latius, Clupisoma garua* and *Nangra viridescens*) were less frequent.

Although the fish fauna of the Park lists 50 species, the present study could record only 40. Seven species namely *Lepidocephalichthys guntea, Noemacheilus botia, N. corica, Aorichthys aor, Eutropiichthys vacha, Channa gachua* and *Chagunius chagunio* recorded by Mahajan (1980), two, namely *Labeo bata* and *L. fimbriatus* reported by Saxena (1975), and one species, *Notopterus chitala* recorded by both of them were not seen during the present study. As the present investigation was a continuous and intensive one for the last four years, we presume that these 10 species must have become locally extinct or were stray records. Disappearance of these species may be due to: (1) alteration or destruction of habitats in the breeding area outside the Park, (2) changes in the habitat inside the Park, (3) over-exploitation, and (4) displacement or competitive exclusion by the 'invaders'. As quantitative data on their abundance and habitat when they were present inside the Park are not available, it is not possible to attribute with certainty any of the above mentioned factors as responsible for their elimination. However, with the available information the following inference is made:

Of the 40 species recorded during the study, only six breed inside and the rest enter through the canal while the water is let in. Among the 10 locally extinct species, it is not clear how many of them were breeding inside. It is likely, two of them, *Channa gachua* and *Notopterus chitala* might have been breeding inside as their congeners *Channa punctatus, C. striatus, C. marulius* and *Notopterus notopterus* are the major breeding species of the Park. As coexistence of congeneric sympatric species is often due to different ecological requirements (Cody 1974, Pontin 1982), a minor alteration of the habitat might affect the chances of their survival. Pertinent at this point is the uncontrolled growth of *Paspalum distichum,* a perennial, amphibious grass, and the subsequent changes in the aquatic system owing to the prevention of buffalo grazing since 1982. Habitat stress leads to competition especially in the congeneric sympatric species which may ultimately exclude the weaker ones (Stephens 1970, Zaret 1971). This may be true for two out of the ten locally extinct species which have their congeners in the Park. Except *Channa gachua, Chagunius chagunio, Lepidocephalichthys guntea, Noemacheilus botia* and *N. corica* all the other species which were not seen now are economically important. Hence over-exploitation might also have played a major role. Tor mahseer, *Tor tor,* one of the important sport fishes reported by Moona (1963) in Ajanbund, was not seen during the present study and it is noticed that there has been a drastic decline in their number in the rivers of North India (Kulkarni 1980, Jhingran 1982)

The local extinction may be the result of all the factors mentioned above, operating together or individually. Our ongoing study on the ecology of major species in the Park may throw more light into this.

ACKNOWLEDGEMENTS

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ECOLOGY OF BABBLERS (*TURDOIDES* SPP.)[1]

V. J. ZACHARIAS[2] & D. N. MATHEW[3]

(*With three text-figures*)

INTRODUCTION

The babblers of the genus *Turdoides* have a wide distribution in India. The Whiteheaded Babbler (*Turdoides affinis*) and the Jungle Babbler (*T. striatus*) occur sympatrically in many parts of South India. Both live in flocks and their ecological requirements overlap in many areas. There are a few informative publications on the ecology of babblers of the genus *Turdoides* (Zahavi 1974, Gaston 1976, 1977). From June, 1974 to September, 1977 one of us (VJZ) had an opportunity to carry out a comparative study of the ecology of *T. affinis* and *T. striatus* in Calicut, S. India. DNM worked on the food and moult of the Jungle Babbler from 1975 to 1977 in the same locality.

Study area:

This study was centred at the Calicut University campus 10° 30′-45′ N, 75° 40′-50′ E and in area of 2.27 km². A considerable part of the area consists of open secondary scrub jungle and stretches of laterite sparsely covered with grass, intermixed with a few groves of coconut and cashew. The terrain is undulating and the elevation *c.* 80 m. The area of collection, Chelannur, Calicut, was more urbanized but with the same climate and type of layout of crops. The elevation at Chelannur varies from sea level to about 100 m.

Climate:

The study area is hot and humid. The warm season from March to May is followed by the southwest monsoon from June to September. It may continue to rain in October and November but rains cease after December. During south-west monsoon rainfall is heavy and amounts to more than half of the total rainfall (Table 1).

Vegetation:

The flora is tropical but tree species are few. Plant formations varied from low scrub dominated by *Calycopteris floribunda* to closed canopy woodland comprising *Macaranga peltata* and *Anacardium occidentale. Lantana camara* forms thickets in areas where the soil is more moist. The centre of the University campus is more or less open with stretches of grass. In the low lying peripheral areas there is less of laterite and the top soil is deeper. Isolated patches of canopy woodlands are common here.

The southern part of the campus is more densely populated and has a few gardens of crops like banana and cassava. Some of them serve as food for the babblers, and all harboured caterpillars and other small animals preyed upon by the birds. Chelannur area is intensively cultivated with crops like paddy, cassava, coconut, mango, cashew, cowpea, snakegourd, bittergourd, yam etc. The secondary scrub jungles are fewer except for the many sacred groves.

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TABLE 1

MONTHLY TOTALS OF RAINFALL RECORDS AT THE CALICUT STATION OF THE METEOROLOGICAL DEPARTMENT

Months	1973	1974	1975	1976	1977
January	000.0	000.0	000.0	000.0	000.0
February	000.0	000.0	005.3	Terace	000.5
March	000.0	08.6	073.4	015.6	002.4
April	62.6	81.6	106.6	134.0	103.4
May	82.8	255.3	149.7	050.1	249.4
June	744.6	305.1	1299.3	209.9	723.0
July	585.1	1700.0	578.8	760.0	998.9
August	501.3	496.8	773.2	254.5	251.1
September	25.2	639.6	648.4	086.2	83.7
October	132.0	61.2	295.2	297.7	439.0
November	73.2	15.8	157.0	335.4	380.6
December	14.8	000.0	012.8	007.5	000.0

METHODS

The babblers were observed using 8 × 30 binoculars. Individual groups were followed for periods from 2-8 hours. For studies of food and moult, specimens of *T. affinis* and *T. striatus* were collected between 1975 and 1977, mostly from Chelannur. Stomachs were preserved in 4% formalin and the contents identified. Insect abundance in the study area was sampled by sweep netting twice a month throughout the year and the number of invertebrates counted.

RESULTS

Turdoides affinis (*c.* 63 g) moves in groups of 3-14 birds in the study area. It forages from dawn to dusk in open fields, grassy hillocks and gardens, progressing slowly by hopping and gliding. It is a poor flier but hops about vigorously on the ground in search of food. *T. striatus* (*c.* 74 g) also occurs sympatrically but in the more sheltered areas full of thickets of lantana. Foraging flocks of both species turn over dead leaves, explore the clumps of grasses, holes on the ground and the crevices on the trunks of trees. The habitat of these babblers in the University campus can be divided into four types.

1) Highly modified areas around human habitation which are systematically watered and cultivated.
2) Open grass-covered hillocks and scrub jungle with a few trees.
3) Closed canopy woodlands 10-12 m. mostly *Macaranga peltata* and *Bambusa arundinacea* with a fairly good undergrowth.
4) Woodland with sparse or no undergrowth, constantly disturbed by removal of vegetation for manuring.

Turdoides affinis occurs in the first, second and fourth types and *T. striatus* in the first, third and fourth types of habitat. The former is usually absent in canopy woodlands and the latter in the open grass-covered hillocks (Fig. 1). Chelannur had very few subhabitats of type 3. Both species of babblers were seen in types 1, 3 and 4 but the Jungle Babbler moved about in shady areas with thickets of lantana or trees like *Macaranga* to seek shelter in.

Though there are differences in colour, size

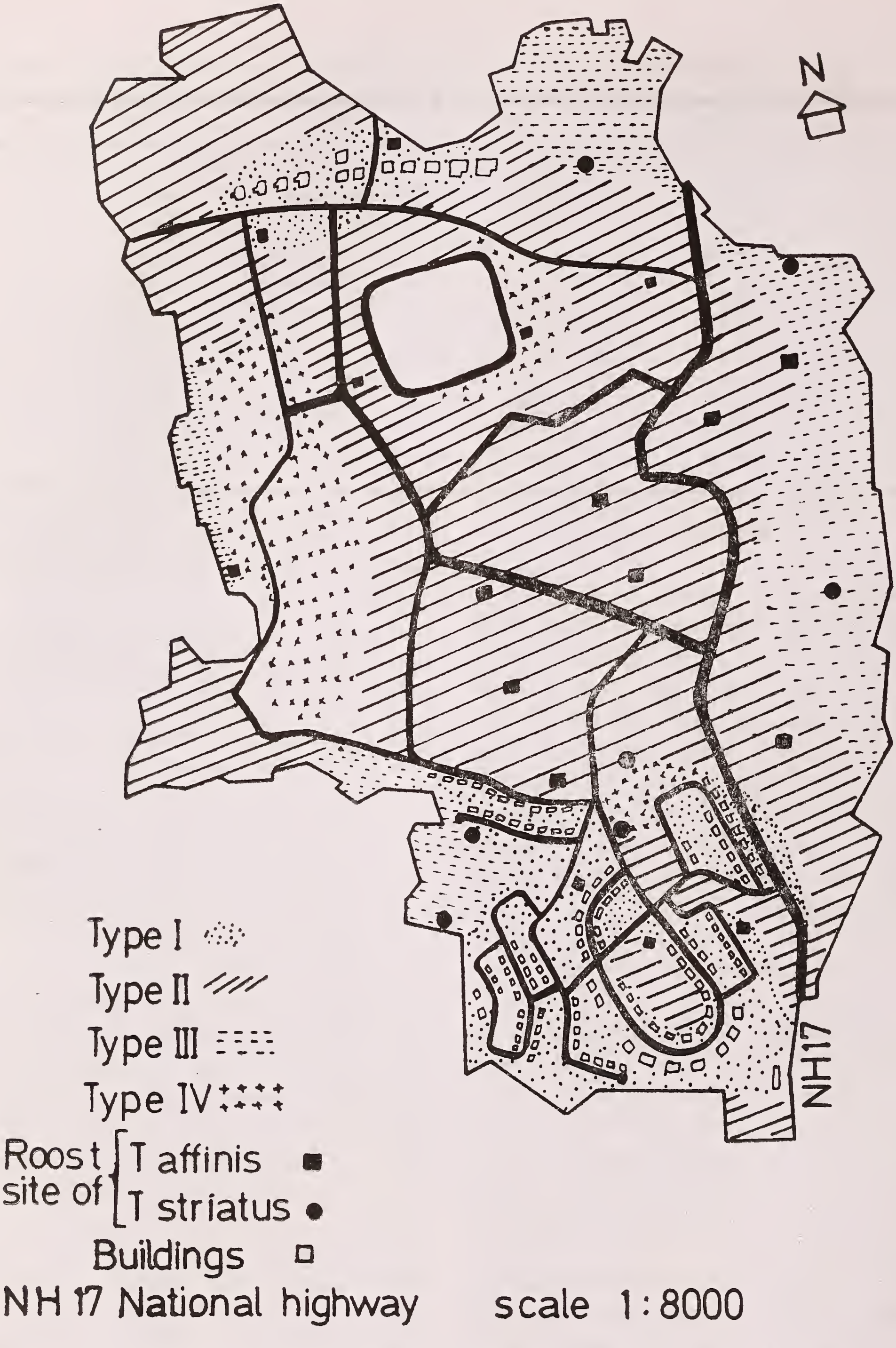
N
NH17
Type I
Type II
Type III
Type IV
Roost site of T affinis ■
T striatus ●
Buildings □
NH 17 National highway
scale 1:8000

Fig. 1. Distribution of the two species of Babblers in the four types of habitats in the Calicut University Campus.

and calls, some of the behavioural patterns of these babblers are very similar. Interesting differences were noticed in their ecological requirements. The sentinel system occurs in both species. The jungle babbler sentinel perched higher than its congener. The Jungle Babblers perched on much higher branches for roosting (Table 2). Many species of trees are shared by groups of both for roosting. The home range of a group of *T. affinis* varied from 5.7 to 9.3 hectares and that of *T. striatus* from 6.3 to 8.9 hectares. Each group had a strongly defended core area inside the home range in which the group roosted and nested. The border areas of two or more groups and of the two species often overlapped. Throughout the period of study the area of the territory maintained by each group remained more or less the same; though some changes occurred in three groups due to the destruction of vegetation and development of a new park in the University campus.

TABLE 2

HEIGHT OF ROOSTING PERCHES IN BABBLERS

Height (m)	*T. affinis*		*T. striatus*	
	Frequency	Percentage	Frequency	Percentage
2-4	16	55.1	5	29.4
4-6	9	31	8	47.5
6 and above	4	13.8	4	23.5
Total	29		17	

FOOD AND FEEDING HABITS

The Whiteheaded Babblers are omnivorous. Their food includes many insects. They spend considerable time searching for food in the open grasslands, scrub jungles, paddy fields, in the compounds of houses, orchards, and gardens. They consume a good quantity of plant food like seeds of *Lantana, Zizyphus,* and *Macaranga,* tubers of cassava and kitchen scraps. Their animal food included insects such as beetles, grasshoppers, caterpillars, termites, bugs, spiders and lizards. Large caterpillars were pinned by the feet and torn to bits before eating, and smaller ones were wedged between the tips of the bill and pulled into the mouth gradually.

The Whiteheaded Babblers probe the holes on the trunks of trees and among the leaf bases of banana and coconut palms in search of food. The leaves of twiners attached to trees like cashew are explored for caterpillars. Time and again they flick dead leaves in search of prey. They dig around the roots of grasses and probe holes on the ground. They forage on trees up to a height of 10 m. flitting from branch to branch. The caterpillars clinging to leaves are sometimes taken by tearing a bit of the leaf along with the prey. The Whiteheaded Babblers usually do not go to the top of taller trees for foraging. The foraging methods of the two species of babblers can be classified into the following categories: (Andrle & Andrle 1976).

1) *Stationary plucking*: The birds hover over bunches of fruits and pluck them.
2) *Inverted feeding*: The birds hang upside down from the leaves to catch caterpillars.
3) *Peering*: The birds twist their heads to one side and peer under leaves from perches in search of caterpillars.
4) *Springing up vertically*: This method is used on trees as well as on the ground. On the trees the birds spring vertically to pluck the overhanging fruits like those of *Macaranga.* On the ground they spring up to catch winged termites and other insects.

5) *Aerial feeding*: Very rarely *T. affinis* jumps into the air from its perch to catch flying insects.
6) *Probing*: The birds insert their bills into curled-up leaves, gaps in the bark and holes on the trunks of trees.
7) *Hopping and gliding*: This is the most common method used close to the ground to catch grasshoppers and crickets.
8) *Lifting of dead leaves*: Birds lift dead leaves on the ground with their bills. The dead leaves are flicked to one side or the other.

Aerial feeding is not used by *T. striatus.* It does not spring up vertically. The methods of foraging are compared in Table 3.

TABLE 3

FORAGING METHODS OF BABBLERS

Methods	*T. affinis*	*T. striatus*
Stationary plucking	22	14
Inverted feeding	30	3
Peering	18	6
Springing vertically	24	2
Aerial feeding	8	—
Probing into curled-up leaves on trees	18	4
Hopping and gliding	40	31
Digging and probing into holes on ground	32	22
Flicking of dead leaves on ground	42	44
Total observations	234	126

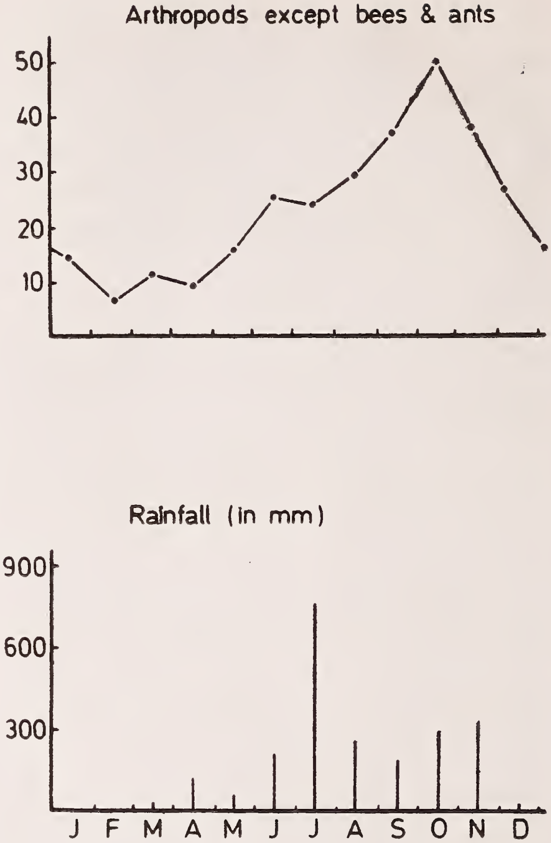

Fig. 2. Monthly abundance of some arthropods and rainfall in the study area.

Sampling of insect abundance in the field showed that all invertebrates were numerous during and after the rains (Fig. 2). The steep increase in June is related to the number of caterpillars which feed on the leaves. Crops such as cassava, paddy and peas are cultivated at the onset of rains and harvested towards the end of the year. Observations in the field and study of the stomach contents showed a direct relationship between the feeding behaviour observed in the field and the quality of food taken. Monthwise studies of the stomach contents of *T. affinis* and *T. striatus* are shown in Tables 4 & 5. Grasshoppers were the most frequent items of food from September to November along with caterpillars. Termites were consumed in large quantities from March to June. Fruits of *Macaranga* were eaten from March to May. Since a large portion of the study area is irrigated, grasshoppers are available in varying quantities throughout the year.

Generally the insects which were available in good numbers in the area of collection

TABLE 4

ANALYSIS OF STOMACH CONTENTS OF *T. affinis* IN VARIOUS MONTHS, 1975-1977

Item	Frequency of each item in a month's sample JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Orthoptera	5	3	2	2	6	5	8	13	12	9	9	8
Dermaptera	–	–	–	–	–	–	–	1	–	–	–	–
Isoptera	11	11	14	13	13	14	9	12	12	15	10	7
Heteroptera	1	–	1	–	2	8	5	7	2	2	3	5
Coleoptera	9	6	9	7	10	10	14	17	18	16	15	11
Hymenoptera	14	9	9	7	9	10	7	11	11	11	13	11
Lepidoptera	2	1	2	–	–	1	2	1	1	4	7	3
Diptera	–	1	–	–	–	–	–	–	–	1	–	–
Myriapoda	–	–	–	–	–	–	–	1	–	1	–	1
Arachnida	1	2	–	–	–	1	2	1	4	4	2	5
Mollusca	–	2	–	1	1	–	–	1	–	–	–	–
Vertebrates (bones)	–	–	–	–	–	–	–	–	1	1	–	1
Seeds & fruits												
Zizyphus jujuba	1	–	–	–	–	–	–	–	–	–	–	–
Leguminosae	–	–	–	–	–	–	–	1	1	–	–	–
Passiflora foetida	–	–	–	–	–	1	–	3	4	4	2	–
Ixora coccinea	1	–	–	–	–	–	–	–	–	–	–	2
Physalis minima	2	–	–	–	–	–	1	3	–	1	–	–
Lantana camara	–	1	1	–	1	1	1	1	3	4	3	6
Macaranga indica	–	–	9	12	–	–	–	–	–	–	–	–
Cassava starch	3	7	6	5	6	6	4	5	8	7	4	3
Oryza sp. (grains)	6	7	3	–	–	–	–	–	1	–	–	–
Graminae	–	1	–	–	–	1	1	2	–	–	–	–
Other seeds & Plant fibres	1	2	1	–	5	3	–	1	1	1	–	1
Total number of specimens examined	14	12	15	13	13	15	15	18	19	17	16	16

during a particular month were the most numerous item of food in the stomach contents for that month. Whiteheaded Babblers tore their prey to small pieces before swallowing it and it was therefore difficult to separate many of the items of food found in their stomach. The Jungle Babbler is slightly larger than its congener and with a larger bill (Table 6) and took slightly larger prey also. Observations in the field and study of the stomach contents both support this view. Although only a few insects were identified up to family level in our sample, the variety of insects consumed appeared to be greater in *T. striatus* (Table 8). The samples also suggested that more individuals of *T. affinis* had consumed termites, bugs and hymenopterans (Table 7) whereas more *T. striatus* had consumed coleopterans. The members of more families of beetles in the stomach contents of *T. affinis* from Cuddapah district, Andhra Pradesh and Palghat District, Kerala. The fruits of *Lantana*, *Passiflora* and *Macaranga* are eaten by both *T. affinis* and *T. striatus.*

Though there is a clear overlap in the items of food of the two species of babblers, they

TABLE 5

ANALYSIS OF STOMACH CONTENTS OF *T. striatus* IN VARIOUS MONTHS, 1975-1977

Item	Frequency of each item in a month's sample											
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
Orthoptera	3	7	2	6	1	10	12	6	18	13	10	8
Isoptera	14	17	16	19	11	17	13	11	7	9	10	8
Heteroptera	4	–	–	4	1	4	2	2	3	1	–	2
Coleoptera	16	14	13	18	11	20	16	19	21	17	16	15
Lepidoptera	–	–	1	1	–	4	–	–	5	3	1	2
Diptera	–	–	–	1	–	–	–	–	1	–	1	–
Hymenoptera	11	7	8	7	8	13	10	14	13	16	11	8
Myriapoda	1	–	–	–	–	–	–	–	–	–	1	1
Arachnida	–	–	–	–	1	–	5	1	–	1	3	3
Mollusca	1	1	–	–	–	–	–	–	–	–	–	–
Vertebrates (Bones)	–	–	–	–	–	–	–	–	1	–	–	–
Seeds & fruits												
Zizyphus jujuba	3	–	–	–	–	–	–	–	–	–	–	–
Laguminosae	2	1	–	–	–	–	–	–	1	1	1	–
Passiflora foetida	–	–	–	–	–	1	–	–	–	–	–	–
Ixora coccinea	–	1	2	1	1	–	–	–	–	–	–	–
Physalis minima	–	–	–	–	–	–	1	2	1	1	–	–
Lantana camara	–	–	–	3	1	1	2	6	5	2	2	–
Macaranga indica	–	–	11	15	–	–	–	–	–	–	–	–
Cassava starch	10	12	3	2	4	9	11	11	10	9	11	5
Oryza sp.	8	9	5	–	2	–	–	–	2	–	2	2
Plant parts	–	1	–	2	–	2	1	2	1	4	1	–
Total number of species examined	16	17	16	22	13	21	17	19	24	17	17	15

TABLE 6

*WEIGHTS AND MEASUREMENTS OF THE TWO SPECIES OF BABBLERS

	T. affinis		*T. striatus*	
Weight (in g)	63.3	(52–70)	74.3	(60–87)
Length (in cm)	22.9	(21–23.5)	24.5	(23.8–25.2)
Wing (in mm)	104	(96–108)	106	(104–108)
Tail (in mm)	98	(95–105)	103	(98–108)
Tarsus (in mm)	35	(32–37)	38	(36–39)
Bill (in mm)	24	(19–24)	28	(22–28)
Total number of specimens	30		15	

* Mean

TABLE 7

INSECTS IDENTIFIED IN STOMACH CONTENTS OF *T. affinis*

Item	Frequency	Percentage*	Remarks
Orthoptera	82	44.8	Acrididae 6, Tettigonidae 5, Mantis 1, Blattidae 1, Cockroaches 10.
Dermaptera	1	0.47	Forficulid.
Isoptera	148	80.8	Termites.
Heteroptera	36	19.7	Fulgoridae 1.
Coleoptera	142	77.6	Carabidae 1, Buprestidae 1, Coccinellidae 3, Tenebrionidae 1, Scarabidae 2, Chrysomelidae 4, Cürculionidae 11.
Hymenoptera	122	66.6	Ichneumonidae 6, Chalcididae 5, Chrysididae (cuckoo wasp) 3. Specoidae 1, Formicidae; *Oecophylla* sp. 37, *Camponotus* 80, *Solenopsis* 2.
Lepidoptera	24	13.1	Geometridae 1, Sphingidae 2.
Diptera	2	1.1	
Total number of specimen examined	183		

* Percentage of the number of specimens which had consumed the item of food.

TABLE 8

INSECTS IDENTIFIED IN THE STOMACH CONTENTS OF *T. striatus*

Item	Frequency	Percentage*	Remarks
Orthoptera	96	44.9	Acrididae 3, Tettigonidae 3, Gryllidae 2, Mantidae: Mantis sp. 4, Phasmidae: Stick insect 2, Blattidae: Cockroaches 18.
Isoptera	152	71	Termites
Heteroptera	23	10.8	Reduviidae 2, Pentatomidae 3, Fulgoridae 1.
Coleoptera	196	91.6	Carabidae 3, Histeridae 1, Buprestidae 3, Cucujidae 2, Coccinellidae 3, Molandridae 1, Tenobrionidae 1, Bostrichidae 1, Scarabidae 14, Melolonthidae 1, Chrysomelidae 4, Curculionidae 19.
Hymenoptera	126	58.8	Ichneumonidae 2, Chalcididae 3, Chrysididae (Cuckoo wasp) 13. Formicidae 18, *Oecophylla* sp. 33. *Camponotus* sp. 84.
Lepidoptera	17	7.9	Geometridae 2.
Diptera	3	1.4	—
Total number of specimens examined	214		

* Percentage of the number of specimens which had consumed the item of food.

appear to adjust with each other and to coexist due to the differences in their feeding behaviour and microhabitat.

BREEDING BIOLOGY

In the study area both *T. affinis* and *T. striatus* breed throughout the year. Ali (1969) reported *T. affinis* to be irregular in breeding. In our study area active nests of *T. affinis* were found during all the months of the year with two peak periods, April and September (Fig. 3). In *T. striatus* which is also an irregular breeder (Ali 1969), there are records of egg laying in all months except June and November. In both species no egg laying was observed in July, the month of heaviest rainfall. Eighty two nests of *T. affinis* and 23 of *T. striatus* were studied.

Nest construction:

The breeding pair is assisted by helpers in *T. affinis* and *T. striatus* for building the nest. First year birds, second year and nonbreeding adults acted as helpers in building the nest.

Nests were built on isolated plants and trees in the scrub jungles, and gardens. Trees like *Anacardium occidentale, Mangifera indica, Strychnos nux-vomica, Artocarpus integrifolia and Cocos nucifera* and bushes such as *Calycopteris floribunda, Memecylon edule* and *Eupatorium odoratum* were used by *T. affinis* for nesting. Garden plants such as *Casuarina* and *Tecoma* were frequently used. In two cases the roofing of a shed constructed of dry folded coconut fronds served as a base for nests. All the plants mentioned above were used by *T. striatus* also for nesting. The nests of the latter were also recorded from *Strychnos nux-vomica,* and *Macaranga indica.* Thirty six per cent of the nests of *T. affinis* were found on *Calycopteris,* 17% on *Anacardium occidentale,* and six per cent on *Strychnos nux-vomica* (Table 9). Twenty eight per cent of the nest of *T. striatus* were found on *Calycopteris floribunda,* 16% each on *Anacardium occidentale, Mangifera indica* and *Macaranga peltata.*

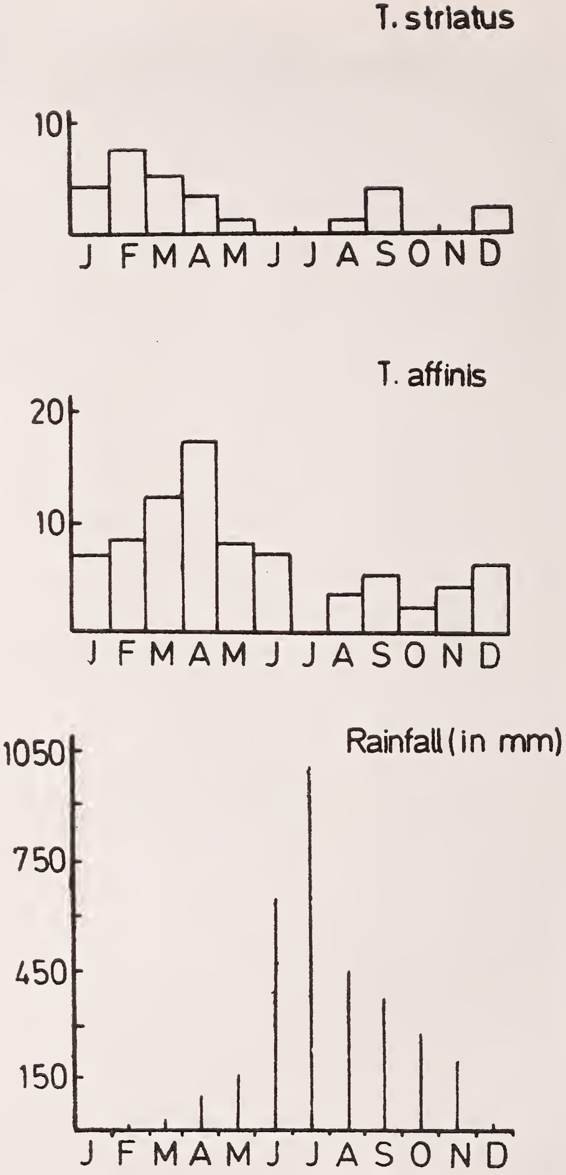

Fig. 3. Rainfall and number of new clutches started.

TABLE 9

PLANTS USED FOR NESTING BY BABBLERS

Species	*T. affinis*		*T. striatus*	
	Frequency	Percentage	Frequency	Percentage
Anacardium occidentale	14	17.2	4	16
Mangifera indica	10	12.3	4	16
Strychnos nux-vomica	5	6.2	–	–
Macaranga indica	–	–	4	16
Artocarpus integrifolia	1	1.2	–	–
Santalum album	1	1.2	1	4
Terminalia paniculata	1	1.2	–	–
Cocos nucifera	4	4.9	1	4
Calycopteris floribunda	29	35.8	7	28
Syzygium caryophyllatum	1	1.2	1	4
Eupatorium odoratum	4	4.9	–	–
Memocylon edule	3	3.7	3	12
Casuarina equisetifolia	3	3.7	–	–
Agava sp.	1	1.2	–	–
Eugenia sp.	1	1.2	–	–
Tecoma stans	1	1.2	–	–
Coconut frond roofing of shed	2	2.5	–	–
Total	81		25	

Nests of *T. affinis* were built at heights of 0.2-6 m from the ground (Table 10). Nests built in the smaller bushes were invariably placed in the centre where they were best concealed. Seventy two per cent of the nests were built below 2 m height from the ground. In *T. striatus* height of the nest varied from 0.5 to 8 m. above the ground.

Herbs such as *Oldenlandia heynii, Borreria stricta, Desmodium triflorum, Canscora pauciflora, Evolvulus alcinoides,* and *Centrosoma verginiana* and coconut husks were used by both species for nest construction. In the ten nests of *T. affinis* examined carefully there was a uniform proportion of coconut husks, *Evolvulus alcinoides* and grasses for the inner lining. Sixty per cent of the nests of *T. striatus* had coconut husks for inner lining.

The duration of nest building in *T. affinis* varied from 3.5 to 6 days and that of *T. striatus* from 4-6 days. In both cases the number of helpers had no relation to the duration of nest building. The completed nest in both species was a loosely put together cup of twigs, roots and grass.

TABLE 10

NESTING HEIGHTS OF BABBLERS

Height (m)	*T. affinis*		*T. striatus*	
	Frequency	Percentage	Frequency	Percentage
1–2 m	14	39.0	5	25
1–2 m	14	28.3	5	25
2–2 m	6	16.6	3	15
3–4 m	2	5.5	3	15
4 & above	2	5.5	5	25
Total	36		20	

Egg laying:

T. affinis and *T. striatus* laid eggs on the day following the completion of the nest. But in *T. affinis*, the first egg was laid only three days after the completion of the nest in three cases, after 16 days in one case and after 18 days in a third. American Goldfinches and some Redstarts of the genus *Mycoborus* may wait a week or more before egg laying begins (Vantyne & Berger 1976).

Eggs of both species were turquoise blue in colour. Twelve eggs from five clutches of *T. affinis* had an average size of 24.0 × 18.6 mm. Ten eggs from three clutches of *T. striatus* had an average size of 26 × 18.5 mm. Freshly laid eggs of *T. affinis* had an average weight of 4.27 g. (16 eggs) and *T. striatus* 4.5 g. (6 eggs).

Clutch size:

The size of the clutch in *T. affinis* varied from 2-6 with an average of 3.1 (N = 80). In three nests were five eggs each. Clutch sizes of 3 and 4 eggs were more common in April and of 2 in March.

The clutch size in *T. striatus* varied from 2-6 with an average of 3.4. Seventy per cent of the nests had 3 eggs, 18 per cent had 4 eggs, 12 per cent 2, and 8 per cent 6 eggs. In the last case the eggs were evidently laid by two females since they were of two sizes (Table 11).

Incubation:

Incubation began with the laying of the first egg in *T. affinis* and *T. striatus*. Some of the second year and adult birds other than the breeding pair also took part in incubation in both species. The interval between the laying of the first egg and the hatching of the last egg varied from 14-16 days. Nestlings were attended to by more than two birds. The number of helpers varied from nest to nest in *T. affinis* and *T. striatus*.

Normally the chicks of *T. affinis* left their nests on the 13th day (N=10) and that of *T. striatus* on the 14th day (N=6) after hatching. Juvenile birds usually stay in their natal groups in both species. But five out of 104 fledglings of *T. affinis* joined neighbouring groups within 40 days after fledging.

Rainfall and Breeding activity:

Even though *T. affinis* and *T. striatus* bred almost throughout the year, the clutch size, intensity of laying and the number of nestlings fledged were better in the period between January and June. No new clutch was started after 8th June and there appears a depression in the breeding activity in July, the month of heaviest rainfall (Gaston, Mathew & Zacharias 1979).

Brood Parasitism:

In September, 1974 and October, 1975 two nests of *T. striatus* were parasitized by *Cuculus varius*. In these two nests the young cuckoos were the only survivors. In September, 1975 a group of *T. affinis* with four birds was observed raising a young *Clamator jacobinus* along with a nestling of their own. In the Palghat area where there are no *T. striatus*, Neelakantan (Pers. comm.) observed several instances of *T. affinis* groups feeding the chicks of *Cuculus varius* without any babbler chicks.

Hatching failure:

Out of 150 eggs studied in 82 nests of *T. affinis*, eight failed to hatch. In 23 nests of *T. striatus* studied, of 77 eggs, only three failed to hatch.

Nesting success:

During the years 1974-1977, 41.6% of the total eggs of *T. affinis* laid, produced fledglings. For *T. striatus*, the percentage of eggs producing fledglings was 43.

Nest's proximity to residences:

Nine nests of *T. affinis* (out of 82) were situated within 1-3 m. from residential buildings and seven of these were successful. None of the *T. striatus* nests were seen close to residential buildings (Table 11).

TABLE 11

CLUTCH SIZE OF THE TWO SPECIES OF BABBLERS

Clutch size	Number of cases observed	
	T. affinis	*T striatus*
2	21	1
3	33	16
4	22	4
5	3	–
6	1	2
Total	80	23

Predation and loss of eggs and chicks:

Many nests of *T. affinis* and *T. striatus* lost eggs and chicks. Predators of eggs included the Ratsnake *Ptyas mucosus* and Crow-Pheasant *Centropus sinensis.* Birds such as *Corvus splendens, C. macrorhynchos. Accipiter badius* and the mongoose *Herpestes edwardsi*, took the chicks of both the species. Two cases of the Ratsnake eating eggs and two cases of devouring of chicks of *T. affinis* were observed. The local people who collect firewood and green leaves for manuring, cut the nesting trees and destroyed several nests.

Changes of iris colour:

In the Whiteheaded Babbler the iris appears to be greenish grey in the newly fledged young. Within the next 3-4 months the iris changes into pale cream colour which is retained in the adult. The dark grey iris of the juvenile Jungle Babbler becomes creamy. These changes are gradual and seemed to be related to post-juvenal moult as observed by Gaston in the Common Babbler *T. caudatus.*

Changes in Weight:

No difference was observed in the weight of the body between sexes. There is little seasonal variation in body weight of both *T. affinis* and *T. striatus.* But the birds are heavier in January and October, and heaviest in October. This may be correlated with (1) the abundance of food supply, (2) preparation for the intensive breeding activity and (3) the termination of flight feather moult.

Moult:

The juvenile Whiteheaded Babblers underwent a partial moult beginning at three months after fledging. This moult was complete only in birds fledged in the early part of the year. In the later fledglings the late developing feathers were retained. They underwent a complete moult in the next year. Pattern of moulting in the Jungle Babbler is similar to that of the Whiteheaded Babbler. The Whiteheaded Babblers and Jungle Babblers nested and renewed their feathers simultaneously, with the body feathers moulting from March to November and the flight feathers from May to November. The duration of primary moult of *T. affinis* and *T. striatus* at the individual level could be crudely calculated as 16-20 weeks (Table 12). Gaston (1981) observed a shorter duration of primary moult in babblers add some other birds in Delhi. In Sarawak, Fogden (1972) recorded the duration of primary moult of individual birds of 18 species ranging from 17-20 weeks. The duration of moult in *T. affinis* and *T. striatus* in the study area is slow compared to temperate birds of seasonal tropics (Delhi) but similar to duration for species of moist tropics.

Group size:

In the study area the group size of *T. affinis*

TABLE 12

COMMENCEMENT AND COMPLETION OF PRIMARY MOULT IN *T. affinis* AND *T. striatus*

Stages of Primary Moult	Earliest recorded date		Last recorded date	
	T. affinis	*T. striatus*	*T. affinis*	*T. striatus*
Commencement of Primary Moult	April 26 (1)	April 20-26 (6)	June 1st week (4)	June 6 (1)
Completion of Primary Moult	Sept. 28 (1)	Aug. 27 (2)	November 1st week (4)	November 1st week (4)

Figures in brackets show the number of specimens examined.

varied from 3-14 and that of *T. striatus* from 4-23. The number of birds in the groups of the two species fluctuated frequently, mainly due to (1) recruitment by breeding, and (2) emigration and immigration. Intergroup movements of birds of all age classes were noticed frequently in *T. affinis.* This phenomenon has been described in *T. striatus* (Gaston 1976) and in *T. squamiceps* (Zahavi 1972). There appears to be a direct relationship between the quality of the habitat and group size in both species.

DISCUSSION

The Whiteheaded Babbler and the Jungle Babbler occur sympatrically in different parts of Malabar. *T. affinis* is smaller than *T. striatus* and is more frequently seen in the open grasslands and scrub jungles than *T. striatus,* which lives in the closed canopy woodlands and other areas with plenty of plant cover. The behavioural patterns of these two species are very similar in spite of the differences in colour, size and call. The two species share many items of food, but differ in their microhabitats, feeding methods and in the proportion in which the different items of food are consumed. A good number of harmful insects such as termites, grasshoppers, beetles and bugs are eaten by both, and their usefulness to man cannot be disputed.

T. affinis and *T. striatus* breed throughout the year with two peak periods. In nest building, incubation and caring of chicks the breeding pair was assisted by helpers in the two species. But some differences were noted in the nesting material collected, the nesting trees, and the height of the nest above the ground. The eggs of both species had the same colour, but the size and weight of the eggs and clutch size were different. Both species had several common predators. The group size of *T. affinis* appeared to be smaller than that of *T. striatus.*

The most significant difference is in the shelter seeking and feeding behaviour. The Jungle Babbler moves in the close vicinity of bushes and trees into which they withdraw immediately on disturbance, their darker coloration merges with the dimly lit background. The lighter coloured Whiteheaded Babbler feeds in the open grassy hillocks and cultivated gardens. Their lighter colour merges beautifully with grassy hillocks.

The moult of the Whiteheaded Babbler and the Jungle Babbler is characterized by (1) its long duration and (2) lack of separation between breeding and moulting activities.

The most prominent difference between groups of Whiteheaded and Jungle Babblers in the study area was the smaller group size of the former. In the Whiteheaded Babbler the groups with fewer members appeared to be more stable than the larger groups.

Though the two species of Babblers have many characters in common, the differences in their ecological requirements allow them to co-exist in the study area. The habitats of both species of babblers are undergoing rapid destruction. The plant cover including low scrub, which is one of the most essential requirements for their survival, is constantly removed. If the destruction of habitat is continued at the present rate, the population of both of these economically useful species will be adversely affected.

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A CONTRIBUTION TO THE FLORA OF KHATLING GLACIER IN THE GARHWAL HIMALAYA (DISTRICT - TEHRI), U.P. — 2[1]

K. S. Negi, J. K. Tiwari and R. D. Gaur[2]

[*Continued from Vol. 84* (3): 598]

Asteraceae

Achillea millaefolium Linn. (Loc.-Guggul)

Erect pubescent herb with white flowers. Tamakundo, 2700 m. Aug. 1985 (3084).

Adenocaulon bicolor Hook.

Erect herb with white flowers or pale yellow heads. Banglani, 2700 m. Aug. 1984 (601).

Ainsliaea aptera DC.

Slender herb with light pink flowers. Jalkala, 2700 m. Aug. 1984 (1296).

A. latifolia (D. Don) Schulz.-Bip.

Tall erect tomentose herb with purplish-white heads. Jalkala, 2700 m. March 1984 (1294).

Anaphalis adnata DC.

Herb with white flowers. Henuri, 2700 m. Aug. 1984 (666).

A. busua (Buch.-Ham.) Hand.-Maz.

Herb with white flowers. Tonyaroo, 2750 m. Aug. 1984 (607).

A. contorta Hook. f.

Herb with white flowers on alpine slopes. Baro Sonaroo, 2800 m. Aug. 1984 (4876).

A. cuneifolia Hook. f.

Woolly or cottony herb with white flowers. Tonyaroo, 2750 m. June 1984 (4865).

A. margaritacea Benth. et Hook. f. Sub. sp. *angustior* Kitamura

Syn. *A. cinnamomea* Clarke

Stout herb with white flowers. Gangi, 2500 m. Sept. 1985 (1297).

A. nepalensis (Spring) Hand.-Manz.

Syn. *A. nubigena* DC.

Woolly tufted herb with white flowers. Bhelbagi, 3100 m. July 1984 (4875).

A. royleana DC.

Herb with white flowers. Kalayani, 2500 m. Aug. 1984 (758).

A. triplinervis Clarke

Large tufted herb with white flowers. Sonaroo, 2600 m. Aug. 1984 (613).

Artemisia sacrorum Ledeb. (Loc.-Chaamari)

Small aromatic shrub with yellow flowers. Henuri, 2750 m. Aug. 1984 (4883).

Aster diplostephioides (DC.) Clarke

Herb with blue flowers. Deokhuri, 2700 m. Aug. 1984 (4863).

A. molliusculus (DC.) Clarke

Pubescent, erect herb with purple flowers. Gangi, 2500 m. June 1984 (4826).

A. peduncularis Wall.

Herb with bluish-white flowers. Kalayani, 2600 m. Sept. 1985 (4869).

Blumea lacinata Roxb.

Herb with yellow flowers. Reeh, 2100 m. May 1984 (1081).

Cirsium arvense (Linn.) Scop.

Syn. *Cnicus arvensis* Hoffm.

Tomentose herb with purplish heads. Jalkala, 2700 m. July 1984 (1298).

C. verutum (D. Don) Spreng.

Syn. *Cnicus involucratus* DC.

Prickly erect robust herb with purplish white

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heads. Naumuthia, 2900 m. Aug. 1984 (2648).

Carpesium abrotanoides Linn.
Herb with yellow flowers in the ravines. Banglani, 2700 m. July 1984 (4888).

Dicrocephala integrifolia D. Don.
Pubescent hairy herb with globose heads. Outer flowers white inner yellow. Dhoperdhar, 1500 m. July 1984 (1299).

Erigeron alpinum Linn.
Erect herb with white pinkish flowers on rocky crevices. Bhelbagi, 3100 m. July 1984 (5705).

E. multiradiatus (DC.) Benth. et Hook. f.
Erect hairy herb with purple flowers. Deokhuri, 2700 m. Aug. 1984 (5728).

Galinsoga parviflora Cav.
Roughly hairy herb with yellowish white heads. Gangi, 2500 m. Sept. 1985 (1108).

Gerbera pusilla (Wall. ex DC.) Goel et Bhattacharyya
Scapigerous small herb with white flowers on shady places. Sonari, 2600 m. Aug. 1984 (782).

Gynura cusimbua (D. Don) S. Moore
Syn. *G. angulosa* DC.
Large glabrous herb with orange yellow corymbose heads on rocky crevices. Reeh, 2000 m. Aug. 1984 (4866).

Helenium grandiflorum (Willd.) O. Kuntz.
Herb with light yellow flowers. Gangi, 2500 m. July 1984 (4864).

Inula cuspidata (DC.) Clarke
Glabrous shrub with purple flowers. Kharsouli, 2800 m. Sep. 1985 (4872).

I. obtusifolia Kerner
Herb with yellow flowers. Kharsoli, 2800 m. Sept. 1985 (4881).

Jurinea macrocephala (DC.) Clarke (Loc.-Guggul)
Stemless herb with sessile purplish heads. Naumuthia, 2700 m. Aug. 1984 (5609).

Lactuca brunoniana (Wall. ex DC.) Clarke
Syn. *Prenanthus brunoniana* Wall. ex DC.
Herb with purple or white heads. Pachari, 2800 m. Aug. 1984 (4884).

L. hastata DC.
Herb with pink-violet flowers. Kharsoli, 2800 m. Sept. 1985 (4880).

L. macrorhiza (Royle) Hook. f.
Weak prostrate herb with purple drooping heads. Pachari, 2800 m. Aug. 1984 (4886).

Leontopodium himalayanum DC.
Syn. *L. alpinum* Hook.
Woolly herb with white flowers. Bhumka, 3200 m. July 1984 (4879).

Myriactis nepalensis Less.
Erect herb with white yellowish heads. Gangi, 2500 m. Sept. 1985 (916).

M. wallichii Less.
Erect roughly hairy herb with white yellowish heads. Gangi, 2500 m. Aug. 1984 (917).

Saussurea albescens Hook. f. et Thoms. ex Clarke
Large cottony herb with purple heads. Birodh, 2700 m. Sept. 1985 (4867).

S. fastuosa (Decne.) Sch.-Bip.
Large herb with purple brown heads. Birodh, 2700 m. Aug. 1984 (5729).

S. graminifolia Wall. ex Hook. f.
Herb with white silky dentely heads. Tonyaroo, 2750 m. Aug. 1984 (5730).

S. hypoleuca Spreng.
Erect herb with dark purple solitary heads. Pachari, 2800 m. Aug. 1984 (1295).

S. leontodontoides (DC.) Sch.-Bip.
Syn. *S. kunthiana* Clarke
Dwarf herbs with deep purple heads. Tonyaroo, 2750 m. Aug. 1984 (5730).

S. obvallata (DC.) Sch.-Bip. (Loc.-Brahmkaunl)
Herb on rocks. Heads enclosed in the membranous uppermost leaves, purplish green. Taamakundo, Chauki, 3800 m. Aug. 1984 (5214).

S. simpsoniana (Field & Gardn.) Lipsch. (Loc.-Phenkamala)

Small woolly herb with woolly heads. Chauki, 3500 m. Aug. 1984 (971).

S. taraxacifolia Wall. ex DC.

Small cottony herb with purple solitary heads. Henuri, 2750 m. Aug. 1984 (4568).

Solidago virga-aurea Linn.

Erect pubescent herb with yellow heads. Panyara, 2700 m. Aug. 1984 (4878).

Senecio chyrsanthemoides DC.

Large herb with yellow flowers. Kalayani, 2600 m. July 1984 (4878).

S. chenopodifolius DC.

Herb with yellow flowers. Chota Sonyaroo, 2750 m. Aug. 1984 (4885).

S. rufinervis DC.

Tall herb with yellow corymbose heads. Lamboo sonaroo, 2700 m. Aug. 1984 (4871).

Tanacetum longifolium Wall. ex DC.

Aromatic hairy herb with yellowish heads. Bhelbagi, 3100 m. Sept. 1985 (1088).

Taraxacum officinale Weber.

Herb with yellow flowers. Kalayani 2600 m. May 1984 (4546).

Tragopogon gracilis D. Don (Loc.-Gwalhya, Daifa)

Tufted herb with yellow flowers. Bhelbagi, 3100 m. May 1984 (4545).

CAMPANULACEAE

Campanula argyrotrica Wall. ex DC.

Procumbent hairy herb with blue flowers. Bhelbagi, 3100 m. May 1984 (3088).

Codonopsis viridis (DC.) Roxb.

Twining herb with large bell shaped yellow flowers. Tamakundo, 3400 m. Aug. 1984 (3091).

Cynanthus lobatus Wall. ex Benth.

Pilose herb with blue, violet or rarely white flowers. Sonari, 2650 m. Aug. 1985 (640).

ERICACEAE

Cassiope fastigiata (Wall.) D. Don

Erect glabrous herb with white flowers forming rigid dense tufts on alpine slopes. Tamakundo, 3400 m. June 1984 (4844).

Gaultheria nummularioides Don

Prostrate hairy herb with pinkish white flowers and blue black fruits. Bhelbagi, 3100 m. July 1984 (4528).

G. tricophylla Royle

Prostrate herb with white flowers and sky blue fruits. Bhelbagi, 3100 m. July 1984 (4529).

Lyonia ovalifolia (Wall.) Drude. (Loc.-Anyar)

Tree with white flowers in racemes upto 15 m long. Gangi, 2500 m. May 1984 (1110).

Rhododendron arboreum Smith (Loc.-Burans)

Tree with red flowers. Kalayani, 2600 m. May 1984 (4526).

R. campanulatum D. Don

Small tree with pale pinkish or white or bluish white flowers. Rimchura, 3000 m. May 1984 (5504).

R. hypenanthum Balf. f.

Syn. *R. anthopogon* auct. non. D. Don (Loc.-Bhotiya chai)

Small shrub with yellow or yellowish white flowers. Bhumka, 3200 m. June 1984 (4527).

R. lepidotum Wall. ex D. Don

Small aromatic shrub with pink or purplish flowers. Bhumka, 3200 m. July 1984 (4595).

PRIMULACEAE

Androsace lanuginosa Wall.

Pubescent, weak and prostrate herb with purple or pink with yellow centre flowers. Reeh, 2100 m. April 1984 (1058).

A. rotundifolia Hardw.

Woolly herb with pink flowers. Gangi, 2500 m. April 1984 (1015).

A. sarmentosa Wall.

Prostrate hairy herb with purple flowers on rocky places. Bhumka, 3200 m. May 1984 (1232).

Lysimachia alternifolia Wall.
Erect slender herb with yellow flowers. Naumuthia, 2900 m. June 1984 (5702).

L. prolifera Klatt.
Prostrate herb with white to pink flowers on grassy slopes. Gangi, 2500 m. June 1984 (5701).

L. pyramidalis Wall. ex Roxb.
Glabrous herb with pale purple flowers. Bhelbagi, 3100 m. July 1984 (792).

Primula denticulata Smith
Erect herb with purple flowers. Kharsoli, 2800 m. April 1984 (1225).

P. floribunda Wall.
Soft herb with yellow flowers on rocks. Naumuthia, 2900 m. June 1984 (3049).

P. sessilis Royle ex Craib
Small tufted herb with purple or pink flowers near dripping water on mossy rocks. Bhelbagi. 3100 m. May 1984 (3100).

SYMPLOCACEAE

Symplocos crataegoides Buch.-Ham. ex D. Don (Loc.-Lodh)
Tree with green yellow flowers. Reeh, 2100 m. June 1984 (5615).

S. ramosissima Wall. ex G. Don
Small tree with green fruits. Gangi, 2500 m. July 1984 (4899).

ASCLEPIADACEAE

Cynanchum canescens (Wall.) K. Schum.
Syn. *C. glaucum* Wall.
Large erect herb with yellow flowers. Kalayani, 2600 m. May 1984 (770).

C. vincetoxicum (Linn.) Pers.
Large erect herb with greenish yellow flowers. Sonari, 2600 m. June 1984 (1067).

GENTIANACEAE

Gentiana argentia Royle ex D. Don
Small herb with blue flowers. Bajloo, 3500 m. May 1984 (1021).

G. capitata Buch.-Ham.
Herb with bluish white flowers. Gangi, 2500 m. April 1984 (993).

G. carinata Griseb.
Small herb with violet flowers. Khatling, 3650 m. May 1984 (2730).

G. pedicellata (D. Don) Wall. ex Griseb.
Erect herb with white or blue flowers. Dhoperdhar, 1000 m. May 1984 (1063).

G. stipitata Edgew.
Small herb with blue purple backed flowers. Bajloo, 3500 m. Sept. 1985 (4671, 1677).

Gentianella tenella (Rottb.) H. Smith
Syn. *G. tenella* Fries.
Small herb with blue flowers. Bhelbagi, 3100 m. Oct. 1985 (1090).

Halenia elliptica D. Don
Erect herb with bluish flowers. Gangi, 2500 m. Oct. 1985 (786).

Swertia ciliata (G. Don) B. L. Burtt.
Erect herb with purplish white flowers on grassy slopes. Birodh, 2700 m. Aug. 1984 (5324).

S. cordata Wall. ex Clarke
Herb with yellow flowers. Kalayani, 2650 m. Aug. 1984 (813).

S. cuneata Wall. ex D. Don
Herb with blue flowers. Khatling, 3600 m. July 1984 (4896).

S. tetragona (Edgew.) Clarke
Erect herb with white pinkish streaks on flowers. Kalayani, 2600 m. Sept. 1985 (4897).

SOLANACEAE

Physalis minima Linn.
Pubescent herb with yellow flowers. Reeh, 2100 m. July 1984 (4584).

SCROPHULARIACEAE

Euphrasia officinalis Linn.

Erect herb with white or pinkish-white flowers. Khatling, 3600 m. Aug. 1984 (3099).

E. platyphylla D. Don

Herb with yellowish-white flowers. Naumuthia, 2800 m. Aug. 1984 (661).

Hemiphragma heterophyllum Wall.

Rambling herb with pink flowers and red shining fruits. Gangi, 2500 m. July 1984 (1039).

Mazus japonicus (Thunb.) Kuntze

Syn. *M. rugosus* Lour.

Tufted glabrous herb with white flowers. Reeh, 2100 m. May 1984 (1112).

M. surculosus D. Don

Tufted herb with pale blue or pinkish white yellow flowers. Tonyaroo, 2750 m. May 1984 (690).

Pedicularis bifida (Buch.-Ham.) Pennell.

Herb with pale rose flowers. Rimchura, 3000 m. Sept. 1985 (3047).

P. hoffmeisteri Klotzsch.

Herb with yellow flowers. Tamakundo, 3400 m. Sept. 1985 (5740).

P. porrecta Wall. ex Benth.

Erect herb with pink flowers. Khatling, 3600 m. July 1984 (711).

Picrorhiza kurrooa Benth. (Loc. Karwi, Kutki)

Spreading herb with light blue flowers. Bhumka, 3200 m. June 1984 (4833).

Scrophularia calycina Benth.

Erect herb with white flowers. Bhelbagi, 3100 m. July 1984 (4898).

Sopubia trifida Ham.

Pubescent herb with yellow flowers. Gangi, 2500 m. Aug. 1984 (1059).

Verbascum chinense (Linn.) Santapau

Erect herb with yellow flowers. Sonari, 2600 m. May 1984 (3048).

Veronica agrestis Linn.

Pubescent herb with blue or white flowers. Gangi, 2500 m. May 1984 (1019).

Wulfenia amherstiana Benth.

Glabrous herb with purple flowers in moist places Panyara, 2700 m. May 1984 (757).

OROBANCHACEAE

Orobanche epithymum DC.

Parasite herb with purple blue flowers. Kalayani, 2600 m. Sept. 1985 (3069).

GESNERIACEAE

Chirita bifolia D. Don

Small herb with purple-blue tinged with yellow flowers in moist places. Reeh, 2100 m. Sept. 1985 (634).

BEGONIACEAE

Begonia amoena Wall.

Glabrous herb with pink flowers on damp rocks. Reeh, 2100 m. Aug. 1984 (622).

ACANTHACEAE

Barleria cristata Linn.

Erect hairy herb with blue flowers. Reeh, 2100 m. July 1984 (3943).

Strobilanthes atropurpureus Nees

Pubescent herb with violet flowers. Deokhuri, 2700 m. Sept. 1985 (742).

LAMIACEAE

Clinopodium umbrosum (M. Bieb.) G. Koch.

Herb with pink flowers. Gangi, 2500 m. July 1984 (1075).

Craniotome versicolor Reichb.

Erect herb with green flowers. Bhelbagi, 3100 m. May 1984 (3076).

Elsholtzia fruticosa (D. Don) Rehder.

Pubescent shrub with white or pale yellow flowers. Tanyaroo, 2750 m. July 1984 (3001).

E. strobilifera Benth.

Small herb with purple flowers. Henuri, 2750 m. Aug. 1984 (3006).

Isodon striatus Benth.

Syn. *Plectranthus striatus* Benth.

Erect hairy herb with white flowers. Jalkala, 2700 m. Aug. 1985 (3005).

Lamium album Linn.

Hairy decumbent aromatic herb with white flowers. Kharsoli, 2800 m. May 1984 (3004).

Micromeria biflora Benth.

Herb with pink flowers. Sonari, 2600 m. Sept. 1985 (947).

Nepeta ciliaris Benth.

Herb with purple flowers. Gangi, 2500 m. Aug. 1984 (745).

N. discolor Royle ex Benth.

Herb with sky blue flowers. Gangi, 2600 m. June 1984 (4900).

N. govaniana Benth.

Pubescent herb with yellow flowers. Gangi, 2600 m. Sept. 1985 (1055, 1061).

Origanum vulgare Linn. (Loc.-Jogpua)

Aromatic erect herb with pink flowers. Kharsoli, 2800 m. Sept. 1985 (4591).

Phlomis bracteosa Royle ex Benth.

Erect hairy herb with dull blue purple flowers. Gangi, 2500 m. Sept. 1985 (3002).

Plectranthus mollis (Ait.) Spreng.

Large erect aromatic herb with bluish flowers. Saura, 2800 m. Aug. 1985 (3074).

Salvia hians Royle ex Benth.

Robust hairy herb with purple flowers. Henuri, 2750 m. Sept. 1985 (729).

S. nubicola Wall. ex Sweet

Syn. *S. glutinosa* Linn.

Aromatic hairy herb with yellow flowers. Pachari, 2800 m. Sept. 1985 (3007).

Scutellaria scandens D. Don (Loc.-Kappu)

Herb with greenish flowers. Tonyaroo, 2700 m. April 1984 (734).

Stachys melissaefolia Benth.

Herb with lilac flowers. Bhelbagi, 3100 m. Sept. 1985 (5237, 5261).

S. sericea Wall.

Herb with rose-pale pink flowers. Jalkala, 2700 m. Aug. 1985 (3072).

PLANTAGINACEAE

Plantago himalaica Pliger

Syn. *P. brachyphylla* Edgew.

Depressed purplish green herb on meadows. Bhelbagi, 3100 m. Aug. 1984 (3077).

P. major Linn.

Herb with spikes upto 0.5 m in length. Dhoperdhar, 1500 m. June 1984 (806).

CHENOPODIAEAE

Acroglochin persicarioides (Poir) Moq.

Syn. *A. chenopodiodes* Schrad.

Erect glabrous herb with spiny inflorescens. Bhelbagi, 3100 m. Aug. 1985 (3011).

Chenopodium ambrosioides Linn.

Tall aromatic herb with yellowish-white flowers. Reeh, 2100 m. July 1984 (1097).

C. botrys Linn.

Strongly aromatic herb. Sonari, 2600 m. Aug. 1985 (3010).

C. foliosum (Moench.) Asch.

Syn. *C. blitum* Hook. f.

Glabrous herb with fleshy red perianth. Rimchura, 2950 m. July 1984 (4624).

C. hybridum Linn.

Glabrous erect herb. Reeh, 2100 m. Aug. 1985 (3009).

C. murale Linn.

Erect herb on drier places. Reeh, 2100 m. Sept. 1985 (4623).

AMARANTHACEAE

Cyathula tomentosa (Roth.) Moq.

Shrub with pale yellow white flowers. Gangi, 2500 m. Sept. 1985 (4619).

Deeringia amaranthoides (Lam.) Merill.
Syn. *D. celosiodes* Br.
Undershrub with pale-yellow green flowers. Gangi, 2500 m. July 1984 (3008).

PHYTOLACCACEAE

Phytolacca acinosa Roxb. (Loc.-Jagroo)
Erect glabrous succulent herb with green flowers. Kalayani, 2650 m. July 1984 (4635).

POLYGONACEAE

Fagopyrum dibotrys (D. Don) Hara
Syn. *F. cymosum* (Trev.) Meissn.
Pubescent erect branching herb with white flowers. Gangi, 2500 m. July 1984. (4554).

F. esculentum (Linn.) Moench. (Loc.-Kanjolya)
Syn. *Polygonum fagopyrum* Linn.
Glabrous herb with pinkish-white flowers. Gangi, 2500 m. May 1984 (4552).

Koenigia delicatula (Meissn.) Hara
Syn. *Polygonum delicatulum* Meissn.
Delicate herb with minute axillary greenish flowers on margins of streams. Tamakundo, 3400 m. Aug. 1984 (5719).

K. nepalensis D. Don (Loc.-Tufrya)
Syn. *Polygonum filicaule* Wall. ex Meissn.
Erect herb with white flowers on margins of streams. Tamakundo, 3400 m. Aug. 1984 (5718).

Oxyria digyna (Linn.) Hill (Loc.-Kailashi almora)
Glabrous fleshy herb with green-pink flowers. Pachari, 2800 m. Aug. 1984 (692).

Persicaria capitata (Buch.-Ham.) H. Gross.
Syn. *Polygonum capitatum* Buch.-Ham.
Trailing herb with pink heads. Gangi, 2500 m. June 1984 (4553).

Polygonum affine D. Don.
Glabrous tufted herb with bright pink flowers and forming mats over rocks. Rimchura, 2900 m. Sept. 1985 (5720).

P. alatum Ham.
Prostrate herb with white-purple flowers. Tonyaroo, 2750 m. Aug. 1984 (3013).

P. alpinum All.
Tall erect herb with white flowers. Rimchura, 2900 m. Aug. 1984 (704).

P. amplexicaule D. Don
Large glabrous herb with red flowers. Kharsoli, 2850 m. May 1984 (5723).

P. donii Meissn.
Procumbent herb with pink flowers on grassy slopes. Reeh, 1800 m. Aug. 1984 (5721).

P. macrophyllum D. Don (Loc.-Kukhuri)
Syn. *P. sphaerostachyum* Meissn.
Herb with drooping red spikes. Kharsoli, 2850 m. Aug. 1984 (706).

P. nepalensis Meissn.
Glabrous herb with terminal greenish and pink heads. Reeh, 1500 m. Aug. 1984 (4547).

P. recumbens Royle ex Bab.
Prostrate herb with white or pink flowers. Pachari, 2850 m. July 1984 (3012).

P. rumicifolium Royle ex Bab. (Loc.Bakranda)
Erect herb with dull pink flowers. Tamakundo, 3200 m. Sept. 1985 (4550).

P. sinuatum Royle ex Meissn.
Creeping herb with pink flowers. Naumuthia, 2900 m. Aug. 1984 (710).

P. vaccinifolium Wall. ex Meissn. (Loc.-Inni)
Trailing herb with light pink flowers on mossy boulders. Rimchura, 3000 m. Aug. 1984 (5722).

Rheum emodi Wall. ex Meissn. (Loc.-Dolu, Archu)
Tall erect herb with white flowers. Rimchura, 3000 m. June 1984 (4558).

Rumex acetosa Linn.
Erect herb with purplish green or pink flowers on moist open meadows. Sonari, 2600 m. Aug. 1984 (4596).

R. nepalensis Spreng. (Loc.-Kholya)

Robust herb with pink flowers. Bhumka, 3200 m. June 1984 (4555).

SAURURACEAE

Houttuynia cordata Thunb. (Loc.-Semdalu)

Aromatic herb with large white flowers on marshy and moist localities. Jalkala, 2700 m. June 1984 (4570).

PIPERACEAE

Peperomia reflexa (Linn. f.) A. Dietr.

Epiphytic herb on *Quercus floribunda* trunks. Sonari, 2600 m. Sept. 1985 (3098).

LAURACEAE

Cinnamomum tamala Nees (Loc.-Guradaroo)

Tree with creamy flowers. Gangi, 2500 m. May 1984 (4573).

Dodecadenia grandiflora Nees

Large evergreen tree in Oak-Rhododendron forest with pale yellow flowers. Gangi, 2500 m. May 1984 (3016).

Neolitsea umbrosa (Nees) Gamble (Loc.-Sailal, Belaru)

Syn. *Litsea umbrosa* Nees

Evergreen tree with pale yellow and small red fruits. Gangi, 2500 m. May 1984 (4593).

THYMELAEACEAE

Daphne papyracea Wall. ex Steud.

Syn. *D. cannabina* Wall.

Shrub with pale white flowers and orange fruits. Panyara, 2750 m. May 1984 (658).

ELAEAGNACEAE

Elaeagnus parvifolia Wall. ex Royle (Loc.-Geiwaii)

Syn. *E. umbellata* Thunb.

Shrub with pale yellowish flowers and red or orange fruits near streams. Deokhuri, 2700 m. Oct. 1985 (4508).

Hippophae rhamnoides Serv. sub spp. **salicifolia** (D. Don) Serv. (Loc-Amali)

H. salicifolia D. Don

Shrub with yellow fruits common on banks of ravine streams. Kalayani, 2650 m. Sept. 1985 (4522).

LORANTHACEAE

Taxillus vestitus (Wall.) Danser. (Loc.-Bandoo)

Syn. *Loranthus vestitus* Wall.

Tomentose shrub with parasite on *Quercus* with brown flowers. Reeh, 2100 m. Sept. 1985 (4581).

Viscum nepalensis Spreng.

Parasitic shrub. Gangi, 2500 m. June 1984 (1038).

SANTALACEAE

Osyris wightiana Wall. ex Wight (Loc. Bakrolya)

Shrub with yellow green and red fruits. Reeh, 2100 m. Aug. 1984 (4572).

EUPHORBIACEAE

Acalypha ciliata Forsk.

Herb with green flowers. Reeh, 2100 m. Aug. 1984 (2138).

Euphorbia pilosa Linn. (Loc.-Mahavir)

Erect glabrous herb with yellow flowers. Birodh, 2700 m. June 1984 (662).

E. stracheyi Boiss. (Loc.-Dudhiya Bish)

Prostrate herb with yellow green flowers. Kharsoli, 2500 m. June 1984 (3019).

BUXACEAE

Buxus wallichiana Baill. (Loc.-Papri)
Syn. *B. sempervirens* Linn.
Small tree with greenish-yellow flowers and horned fruits. Gangi, 2500 m. May 1984 (4722).

Sarcococca saligna (Don) Muel.-Arg.
Syn. *S. pruniformis* Lindl.
Glabrous shrub with green flowers. Pachari, 2800 m. May 1984 (731, 1029).

MORACEAE

Ficus sarmentosa Ham. ex Smith
Evergreen creeping shrub with green fruits. Reeh, 2100 m. April 1984 (3020).

F. scandens Roxb. (Loc.-Beduli)
Creeping shrub with black fruits on moist rocky places. Gangi, 2500 m. Oct. 1985 (4377).

Morus serrata Roxb. (Loc.-Keemu)
Tree with dark purple sweet fruits. Ghutoo, 1500 m. June 1984 (4576).

URTICACEAE

Boehmeria platyphylla Don
Large herb with white flowers. Reeh, 2100 m. July 1984 (646, 659).

B. scabrella Gard. (Loc.-Khagsa)
Shrub with pale yellowish flowers. Common along canals and streams. Gangi, 2500 m. Aug. 1984 (5733).

Debregeasia salicifolia (D. Don) Rendle (Loc.-Syanru)
Shrub with orange yellow fruits. Ghutoo, 1500 m. May 1984 (4149).

Elastostemma surculosum Wight.
Erect tufted herb with greenish flowers on damp rocky slopes. Pachari, 2800 m. Aug. 1984 (777).

Gonostegia hirta Miq.
Syn. *Pouzolzia hirta* Haussk.
Decumbent herb with creamy flowers. Reeh, 2100 m. July 1984 (3021, 698).

Lecanthus wallichii Wedd. (Loc.-Chaul)
Herb in moist places near water margins. Jalkala, 2700 m. Nov. 1984 (4664).

Pouzolzia zeylanica (Linn.) Benn.
Small herb with pale green flowers. Ghutoo, 1500 m. July 1984 (697).

JUGLANDACEAE

Juglans regia Linn. (Loc.-Akhor)
Tree with fragrant greenish male catkins. Gangi, 2500 m. June 1984 (4857).

MYRICACEAE

Myrica esculenta Hamilt. ex Don (Loc.-Kaphal)
Small tree with red fruits. Gangi, 2500 m. May 1984 (4729).

BETULACEAE

Alnus nepalensis Don (Loc.-Ust)
Deciduous tree with yellowish green catkins. Gangi, 2500 m. Sept. 1985 (4706).

Corylus jacquemontii Decne. (Loc.-Kabasi)
Syn. *C. colurna* Linn.
Small deciduous tree with large nuts sheathed by much enlarged bracteole. Deokhuri, 2700 m. June 1984 (4536).

Betula utilis D. Don (Loc.-Bhoj)
Tree with greenish catkins and exfoliating papery bark. Rimchura, 2950 m. June 1984 (4709).

FAGACEAE

Quercus leucotrichophora A. Camus ex Bahadur (Loc.-Banj)
Tree with pale yellowish catkins. Reeh, 2100 m. Sept. 1985 (4856).

Q. glauca Thunb. (Loc.-Phanat)
Tree with greenish catkins. Gangi, 2500 m. Sept. 1985 (5616).

Q. himalayana Bahadur (Loc.-Moru, Tilonj)
Syn. *Q. dilatata* Lindl.
Tree with greenish catkins. Kharsoli, 2800 m. Aug. 1984 (5617).

Q. semecarpifolia Smith (Loc.-Kharsu)
Tree with greenish blue catkins. Kharsoli, 2800 m. June 1984 (1084).

SALICACEAE

Salix daphnoides Villars.
Tree with female catkins. Rimchura, 3000 m. June 1984 (5726).

S. elegans Wall. ex Anders.
Syn. *S. denticulata* Anders.
Small tree with 4-6 cm long catkins. Pachari, 2800 m. May 1984 (5714).

S. fruticulosa Anders.
Shrub with hairy catkins about 0.8-2.2 cm long. Kharsoli, 2800 m. June 1984 (3725).

S. furcata Anders.
Small shrub with red flowers. Stamens exerted, Chauki, Khatking, Dandakharak, 3800 m. May 1984 (5724).

S. wallichiana Anders. (Loc.-Gadhbhains)
Small tree. Catkins 7-10 cm long appearing before leaves. Kalayani, 2600 m. May 1984 (5733).

MONOCOTYLEDONS

ORCHIDACEAE

Cephalanthera ensifolia Rich.
Glabrous herb with white flowers. Birodh, 2700 m. June 1984 (764).

Cypripedium cordigerum D. Don
Glabrous herb with green flowers. Birodh, 2700 m. June 1984 (769).

Epipactis latifolia (Linn.) All.
Glabrous herb with purple flowers. Rimchura, 2800 m. June 1984 (3096).

Eria convallarioides Lindl.
Epiphytic on spp. of *Litsea, Quercus.* Ghutoo, 1500 m. Sept. 1985 (778).

Goodyera repens (Linn.) R. Br.
Glabrous herb with white flowers. Naumuthia, 2900 m. Aug. 1984 (966, 3093).

Habenaria ensifolia Lindl.
Glabrous herb with white flowers. Henuri, 2750 m. Aug. 1984 (670).

H. intermedia D. Don
Glabrous herb with greenish white flowers. Tamakundo, 3400 m. Aug. 1984 (671).

H. latilabris (Lindl.) Hook. f.
Syn. *Plantanthera latilabris* Lindl.
Glabrous herb with white blue flowers. Reeh, 2100 m. July 1984 (3097).

H. plantaginea Lindl.
Glabrous herb with white blue flowers. Khatling, 3500 m. June 1984 (3098).

Herminium angustifolium Benth.
Glabrous herb with green flowers. Bhumka, 3200 m. Aug. 1984 (675).

Malaxis cylindrostachya (Reich.) O. Ktze.
Syn. *Microstylis muscifera* (Lindl.) Ridle.
Fleshy herb with greenish-yellow flowers. Gangi, 2500 m. Aug. 1984 (3098).

Neottia listeroides Lindl.
Glabrous leafless herb with yellowish-green flowers. Kalayani, 2600 m. Aug. 1984 (1020).

Oberonia pachyrachis Reichb. f.
Succulent leaved herb on tree trunks. Spikes with cylindric fleshy rachis, minute flowers depressed in it. Kharsoli, 2800 m. Sept. 1985 (3095).

Orchis latifolia Linn. (Loc.-Hatthajari)
Erect herb with dull purple flowers and palmate tubers. Bhelbagi, 3100 m. Aug. 1984 (4848).

Satyrium nepalense D. Don
Herb with purple flowers on rocks with *Sedum* spp. Gangi, 2500 m. Sept. 1985 (3092).

Spiranthes sinensis (Pers.) Ames.

Herb with pink or red flowers. Gangi, 2500 m. Aug. 1984 (968, 3059).

ZINGIBERACEAE (SCITAMINACEAE)

Cautleya gracilis (Smith) Pandey

Syn. *C. lutea* Royle

Herb with yellow flowers. Gangi, 2500 m. Aug. 1984 (624).

Roscoea alpina Royle

Small herb with lilac to purple flowers on grassy slopes and in rocky crevices. Kalayani, 2600 m. June 1984 (5709).

HAEMODORACEAE

Mondo intermedium (D. Don) Bailey

Syn. *Ophiopogon intermedius* D. Don

Glabrous herb with white drooping flowers. Gangi, 2500 m. July 1984 (1221).

IRIDACEAE

Iris kumaonensis Wall. ex D. Don

Glabrous herb with blue flowers on grassy slopes and meadows. Bhumka, 3200 m. June 1984 (5708).

DIOSCOREACEAE

Dioscorea belophylla Voight (Loc.-Tairu)

Syn. *D. glabra* Roxb.

Slender herbaceous climber with greenish flowers. Reeh, 2100 m. Aug. 1984 (4535).

D. bulbifera Linn. (Loc.-Genthi)

Glabrous climber with brownish white flowers. Reeh, 2100 m. Aug. 1984 (4531).

D. deltoidea Wall. ex Kunth.

Herbaceous twiner on *Berberis, Pyrus* spp. with greenish flowers. Gangi, 2500 m. Sept. 1985 (4532).

D. melanophyma Prain ex Burkill (Loc.-Mag, Maghaii)

Twining herb around spp. of *Berberis, Malus, Prinsepia.* Kalayani, 2650 m. Oct. 1985 (4554).

LILIACEAE

Disporum cantoniense (Lour.) Merill.

Syn. *Fritillaria cantoniensis* Lour.

Glabrous herb with white flowers. Birodh, 2700 m. May 1984 (3029).

Cardiocrinum giganteum (Wall.) Mukino

Syn. *Lilium giganteum* Wall.

Large herb with white flowers, tube dark purple inside. Rimchura, 2900 m. June 1984 (5613).

Fritillaria roylei Hook.

Bulbous herb with bell-shaped white flowers. Birodh, 2750 m. May 1984 (2744).

Gagea lutea (Linn.) Ker.-Gwal.

Herb with yellow flowers. Jalkala, 2700 m. April 1984 (5419).

Iphigenia indica Kunth

Bulbous herb with purple flowers. Ghutoo, 1500 m. Aug. 1984 (3024).

Lilium polyphyllum D. Don ex Royle

Herb with greenish-white flowers with purple dots inside. July 1984 (3028).

Llyodia serotina Reichb.

Herb with bell shaped white flowers in crevices of rocks. Saura, 3000 m. May 1984 (3030).

Paris polyphylla Smith

Rhizomatous herb with greenish flowers near stream along with *Sarcococca* spp. Kalayani, 2600 m. June 1984 (5711).

Polygonatum cirrhifolium (Wall.) Royle

Rhizomatous herb with white, tinged with green or purple flowers. Deokhuri, 2700 m. May 1984 (3025).

P. verticilliatum All.

Rhizomatous herb with yellowish white tinged with green flowers. Deokhuri, 2700 m. May 1984 (4539).

Smilacina purpurea Wall.

Herb with purplish flowers. Henuri, 2700 m. Aug. 1984 (810).

Trillium govanianum (D. Don) Kunth

Tuberous herb with solitary purple flowers. Tamakundo, 3100 m. Aug. 1984 (5710).

AMARYLLIDACEAE

Allium humile Kunth (Loc.-Laadoo, Pangri)

Syn. *A. govanianum* Wall. ex Baker

Small herb with white flowers on grassy slopes. Bhumka, 3200 m. May 1984 (4530).

A. wallichii Kunth (Loc.-Gobka)

Large herb with dark purple flowers. Rimchura, 2600 m. Aug. 1984 (4536).

SMILACACEAE

Smilax aspera Linn.

Prickly climber with white flowers. Gangi, 2500 m. Sept. 1985 (3027).

S. glaucophylla Klotzsch

Syn. *S. parvifolia* Wall.

Climber with white flowers. Gangi, 2500 m. May 1984 (3026).

COMMELINACEAE

Commelina paludosa Blume

Syn. *C. obliqua* Buch.-Ham.

Herb with large sky blue flowers. Birodh, 2700 m. Aug. 1984 (4647).

Murdannia divergens (Clarke) Bruckn.

Herb with red blue flowers on grassy slopes. Gangi, 2500 m. Aug. 1984 (3031).

JUNCACEAE

Juncus elegans Royle ex D. Don

Syn. *J. concinus* D. Don

Herb with white spikes near water margins. Bhelbagi, 3100 m. Aug. 1984 (679).

Luzula multiflora (Retz.) Lej.

Herb with reddish-brown spikes. Kharsoli, 2800 m. May 1984 (1214).

ARACEAE

Arisaema jacquemontii Blume

Herb with green spathe white striped on rocky places. Pachari, 2500 m. June 1984 (5707).

A. wallichianum Hook. f. (Loc.-Meen)

Herb with dark purple white striped spaths. Pachari, 2850 m. June 1984 (4852).

Gonatanthus pumilus (Don) Engl. ex Krause

Bulbous herb with spathe on moist slopes. Gangi, 2500 m. June 1984 (4565).

Typhonium diversifolium Wall. ex Schott.

Bulbous herb with green spathe. Jalkala, 2750 m. June 1984 (4851).

CYPERACEAE

Carex breviculmis R. Br.

Grass with brown spikes Kharsoli, 2800 m. June 1984 (1028).

C. filicina Nees

Syn. *C. meiogyna* Nees

Grass with reddish-brown spikelets. Chauki, 3800 m. Sept. 1985 (1218).

C. inanis Kunth

Grass with dark brown-green spikes. Bhumka, 3800 m. June 1984 (1018).

C nivalis Boott.

Grass with yellow or pale brown spikes. Chauki, 3800 m May 1984 (1217).

C. nubigena D. Don

Grass with green or pale brown spikes. Bhumka, 3200 m. July 1984 (1219).

C. rostrata Stocks

Grass with green or pale brown spikes. Bhumka, 3200 m. July 1984 (5614).

C. setosa Boot.

Glabrous herb with shining brown spikes. Bhelbagi, 3100 m. Aug. 1984 (3033).

Cyperus cuspidata Kunth (Loc.-Chandrica)

Herb with reddish pale yellow spikelets. Kharsoli, 2900 m. Sept. 1985 (3032).

C. sanguinolentus Vahle.

Rhizomatous herb with purplish spikelets. Bhelbagi, 3100 m. July 1984 (767).

Fimbristylis dichotoma (Linn.) Vahl

Syn. *Scirpus dichotomus* Linn.

Herb with brownish red spikelets. Gangi, 2500 m. July 1984 (3055).

Kobresia nitens Clarke

Grass with greenish spikes. Bhelbagi, 3100 m. June 1984 (3045).

POACEAE

Agrostis canina Linn.

Grass with purple green panicles. Gangi, 2500 m. Oct. 1985 (3030).

A. pilosula Trin.

Grass with brown spikes. Kalayani, 2600 m. July 1984 (1202).

A. stolonifera Linn.

Erect grass with purplish spikelets. Kalayani 2650 m. Aug. 1984 (3036).

Andropogon tristis Nees

Tufted herb with greenish hairy spikelets. Henuri, 2750 m. Aug. 1984 (1040).

Arthraxon lancifolium (Trin.) Hochst.

Syn. *A. microphyllus* Hochst.

Grass with purplish green spikelets on rocks near hill streams. Gangi, 2500 m. Sept. 1985 (1098).

Apluda mutica Linn. (Loc.-Jatchlyu)

Grass with greenish spikelets. Gangi, 2500 m. Sept. 1985 (759).

Danthonia cachymeriana Jaub. et Spach.

Densely tufted grass with pinkish-brown spikes. Chauki, Khatling, 3600 m. Aug. 1984 (1201).

Dactylis glomerata Linn.

Herb with greenish spikelets in dense one-sided clusters on the branches on panicles. Bajloo, 3500 m. July 1984 (1206).

Deyeuxia pulchella (Griseb.) Hook. f.

Tufted grass with grey-purple spikes on open slopes amongst boulders. Bajloo, 3500 m. Aug. 1984 (1215).

D. scabrescens (Griseb.) Munro ex Duthie

Large grass with pinkish-brown spikelets. Bhelbagi, 3100 m. Aug. 1984 (1203).

Caplipedium parviflorum (R.Br.) Stapf

Syn. *Chrysopogon parviflorum* (R.Br.) Benth

Herb with purplish spikelets. Reeh, 2100 m. Aug. 1984 (1205).

Eragrostis poaoides P. Beauv.

Syn. *E. nigra* Nees ex Steud.

Grass with black spikes. Kalayani, 2600 m. June 1984 (1212).

Festuca kashmiriana Stapf

Tufted grass with green purple tinged panicles. Birodh, 2700 m. Aug. 1984 (3043).

F. ovina Host.

Herb with pale green or purplish spikes. Bhelbagi, 3100 m. Aug. 1984 (1028).

F. valesiaca Schleich. ex Gaud.

Tufted grass with pale green spikelets. Bhelbagi, 3100 m. Aug. 1984 (3041).

Helictorichon virescens Nees ex Steud.

Large erect slender grass with green spikelets Saura, Birodh, 2800 m. Aug. 1984 (3040).

Koeleria gracilis Pers.

Syn. *K. cristata* auct. non Pers.

Tufted grass with shining green spikelets. Bhelbagi, 3100 m. Aug. 1984 (1026, 1214).

Oryzopsis munroi Stapf ex Hook. f.

Grass with greenish-purple spikes near water margins. Kharsoli, 2800 m. June 1984 (3054).

Phleum alpinum Linn.

Herb with blackish-green spikelets. Bhelbagi, 3100 m. Aug. 1984 (3056).

Poa alpina Linn.

Tufted herb with silky hairy spikes. Bhumka, 3200 m. June 1984 (3035).

P. nepalensis Wall. ex Duthie

Herb with green spikelets. Bhelbagi, 3100 m. May 1984 (3039).

P. pagophila Bore

Herb with purplish spikelets. Bhumka, 3200 m. June 1984 (3034).

Setaria viridis (Linn.) Beauv.

Herb with green purple bristles. Gangi, 2500 m. July 1984 (1211).

Sporobolus fertilis (Steud.) Clyton

Syn. *S. indicus* auct. Linn.

Herb with purplish-green narrow panicle. Bhelbagi, 3100 m. Aug. 1984 (1207).

Trisetum aeneum (Hook. f.) Stewart

Grass with purplish green spikes. Kharsoli, 2800 m. Aug. 1984 (1209).

T. spicatum (Linn.) Richt.

Grass with greenish spikes. Kharsoli, 2800 m. Aug. 1984 (1209)

Muhlenbergia duthiana Hack.

Herb with eroded erect silvery green spikelets. Kharsoli, 2800 m. Aug. 1984 (796).

The little known taxa recorded in the present work are *Carex rostrata* Stocks, and *Sorbus lanata* (Don) S. Schaur. *Carex rostrata* was collected from an elevation of 3200 m. and *Sorbus lanata* was collected in between 2600-2900 m. elevation range.

As expected, the vegetation and the flora of the region are subjected to several natural calamities, such as land slides, soil erosion and forest fires. However, more harmful changes are brought about by human activities. Shepherds (Gaddis, Gujars, Gangwals) invade the high altitude zones in the month of April to bring their flocks of sheep for grazing till late October, as a result adversely affecting the environment. Moreover, numerous high altitude medicinal plants e.g., *Aconitum heterophyllum, A. balfourii, Actaea spicata, Bergenia stracheyi, Diospyrum cantoniensis, Rhododendron lepidotum, Rheum emodi, Orchis latifolia, Skimmia laureola, Nardostachys grandiflora, Jurinea macrocephala*; Barks of *Cinnamomum tamala, Myrica esculenta, Berberis asiatica, B. aristata, Taxus wallichiana*; whole plants of *Meconopsis aculeata, Plantago himalayana, P. major, Swertia cordata, S. ciliata, Syringa emodi* are collected without understanding future prospects. Nevertheless, the region serves as reservoir for numerous valuable economic plants, many of which are known to be endangered or threatened.

Besides the above, wanton felling of forests, clearing of forests for cultivation, deforestation for firewood, tapping of resin, and minor hydroelectric projects, forest fires etc. are causing havoc to the natural vegetation and making many areas barren leading to soil erosion, floods, land slides, drought and other natural calamities (cloud bursts etc.), ultimately bringing a serious disharmony in the lower valleys of Khatling Glacier. In the near future such type of activities will create a serious problem for the Himalaya as well as for the country.

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FEEDING ECOLOGY OF THE MUD CRAB, *SCYLLA SERRATA* (FORSKAL) FROM SUNKERI BACKWATERS, KARWAR[1]

P. N. Prasad, R. Sudarshana and B. Neelakantan[2]

(*With four text-figures*)

Sunkeri backwaters (14°48′ N and 74°51′ E) offer a congenial environment with diversified feeding habitats for the mud crab, *Scylla serrata* (Forskal). The feeding habits of this crab depend mainly on the conditions prevalent in the mangroves, backwater bunds and axial depressions of this water body. In the general assessment, the crab has been found to be omnivorous, feeding on the remains of mollusca, fish and crustacea and a moderate amount of detritus. Apart from the food composition, an interesting relationship between the gut volume and the size (carapace width) of the crab has been discussed. It is seen that the relationship is linear and exponential. Some observations on the feeding behaviour of the crab have also been made, indicating that the crab is an active nocturnal feeder being more mobile than buried in the substratum.

INTRODUCTION

Scylla serrata (Forskal) is a large mud crab distributed widely in the estuaries of Indo-Pacific region (Stephenson 1962) being reported as a predator of slow moving and sessile benthic organisms (Hill 1976) but omnivorous (Arriola 1940) in the general assessment. However, the feeding ecology of this crab depends on the source and abundance of its food ingredients in the environment. Sometimes, the enormous salinity variations (McLachlan & Erasmus 1974) in the estuaries have been found to alter the feeding ecology of the crab. But, in spite of the enormous commercial importance and functional interest attached to the mud crab *S. serrata*, the aspects of its feeding ecology in Indian waters, especially in Sunkeri backwaters, Karwar (14°18′N; 74° 51′ E) are not well described. Therefore, this attempt is aimed at explaining the relationships of foregut volume, food composition and feeding behaviour of the mud crab.

MATERIAL AND METHODS

The crabs were collected during the post-monsoon period (Sept.-Mar.) from Sunkeri backwaters lying at a distance of 3 km. from the mouth of the Kali estuary (Fig. 1). The collections were essentially from three different areas, namely mangroves, backwater bunds and axial depressions. The salient features of these habitats, along with the hydrological parameters, are described in Table 1. As can be seen from this Table, the hydrological conditions of mangroves and axial depressions were very similar while the backwater bunds exhibited a unique pattern. However, owing to the greater depth, tidal activity and the congenial bottom texture, most of the crabs for the present study were procured from the axial depressions. As there has not been much difference in the gut conditions between crabs collected from these areas, and as the crab is a nocturnal wanderer (Hill 1976)

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on the bottom of the estuaries, there cannot be a habitat isolation for the crabs under different feeding conditions. Therefore the crabs collected from three different areas of Sunkeri backwaters have been treated as of one stock which enjoyed the diversity in food resources in the environment. Even though the crabs in these waters are caught by line and hook, the crabs from cast nets alone were procured for the study to avoid "bait-contamination" in the gut contents of the crabs.

Hydrography :

Salinity and temperature of the study area were determined by using a standardised salinity-temperature meter. Oxygen content was estimated by Winkler's titrimetric method and phosphate and nitrite were determined by colorimetric methods, as described by Strickland & Parsons (1977).

Morphometry:

The crabs were frozen to immobility and washed thoroughly to free adhering foreign particles like sand, mud, etc. The weight of the crab was determined in a microbalance to the nearest milligram. The width of the crabs was measured to the nearest millimetre with the help of vernier calipers as suggested by Stephenson (1966). Crab volume was measured by displacement after immersing the whole crab with all appendages intact, in a measuring cylinder.

The foregut volume was estimated by the method described by Hill (1976) as follows. The foreguts of 32 freshly killed crabs (41-110 mm carapace width) were exposed by dissection and isolated from the midgut by cutting posterior to the filter chamber. All muscle attachments were disconnected, the oesophagus was ligatured and cut, after which the foregut was removed from the crab. It was then filled with water injected through the cut end of the filter chamber and the total volume of gut wall plus content was measured by displacement in a measuring cylinder. The foregut was then punctured and completely emptied and the volume of the gut wall was measured by displacement. The difference gave the foregut volume.

Food volume was calculated by substracting foregut volume from volume of foregut plus contents.

Relative volume of the gut was calculated by dividing the gut volume with crab volume and multiplying by 100.

Food composition:

The guts of the deepfrozen crabs were opened. After measuring the foregut volume, the contents therein were brushed down into a petri-dish or slide, and identified under a microscope. The different constituents were quantified volumetrically and the results presented as percentages of total food.

An experiment was conducted on feeding behaviour of the mud crab and is described.

RESULTS

As discussed earlier, the habitat types and their salient features are given in Table 1. Table 2 enumerates the relative gut volume, gut plus food volume, calculated and measured gut volumes and percentage of fullness of the guts in relation to the size (carapace width) groups. The condition of the gut and food composition are presented in Table 3. The abundance of different food ingredients in different size groups of *S. serrata* is indicated in this table.

The location of the study area and distribution of the different habitats as mentioned in Table 1 are shown in Fig. 1. Fig. 2 shows the indirect relationship between the relative gut volume and carapace width. A bimodal

TABLE 1

SALIENT FEATURES OF THE FEEDING HABITATS OF *S. serrata* IN SUNKERI BACKWATERS

Sl. No.	Habitat type	Salient features	Salinity ‰	Temp. °C	Oxygen ml/l	Phosphate μg at/l	Nitrite μg at/l
1.	Mangroves	Vegetated with *Avicennia* & *Rhizophora* sp. Rich benthic biomass and species diversity. Sandy-silt and silty-clay bottoms.	21.42±3.22	27.38±01.56	5.20±0.87	0.17±0.13	0.48±0.36
2.	Backwater bunds	Moderate benthic biomass and diversity. Crevices and hiding spaces. Silty-clay bottoms.	21.68±3.45	27.44±1.92	5.04±1.47	0.32±0.23	0.47±0.36
3.	Axial depressions	Sand and sandy-silt bottoms. Deeper than other habitats. Enormous tidal activity.	21.42±3.22	27.38±1.56	5.20±0.8	0.17±0.13	0.48±0.36

TABLE 2

VOLUME AND CONDITION OF THE CUTS IN DIFFERENT SIZE GROUPS

Size groups & no. of crabs examined	Relative gut volume %	Gut + Food volume ml	Gut Volume – Calculated ml	Gut Volume – Measured ml	% of fullness
41-50 4 nos. (48.70±0.56)	1.26±0.22	0.75±0.15	0.35±0.01	0.35±0.08	52.80± 9.92
51-60 14 nos. (55.46±2.41)	1.34±0.35	0.80±0.25	0.44±0.03	0.48±0.09	32.87±14.58
61-70 2 nos. (66.35±0.05)	0.83±0	1.25±0.25	0.63±0.001	0.68±0.08	45.00± 5.00
71-80 7 nos. (76.07±3.10)	0.95±0.11	1.39±0.42	0.86±0.09	0.99±0.33	28.17±12.69
81-90 2 nos. (85.95±0.45)	1.06±0.11	1.50±0	1.19±0.02	1.15±0.15	23.33±10.00
91-100 2 nos. (97.45±1.05)	0.83±0.08	2.50±0.50	1.75±0.06	1.55±0.50	35.00±15.00
101-110 1 no. (105.5±0)	0.01±0	3.00±0	2.28±0	2.50±0	16.67±0

Table 3

Percentage composition of the gut contents in different size groups

Size group (mm)	Fullness of gut (%)	Food volume (ml)	Crustacean remains (%)	Molluscan remains (%)	Fish remains (%)	Detritus (%)	Unidentified and degenerated fish (%)
41-50	52.80± 9.92	0.40±0.13	—	10.00±0	—	90.00±0	—
51-60	32.87±14.58	0.26±0.13	3.00± 4.00	8.40± 8.50	6.00± 4.90	77.60±12.53	5.00± 7.75
61-70	45.00± 5.00	0.58±0.18	6.20± 9.85	4.80±9.13	21.00±25.77	24.50±25.24	33.50±31.78
71-80	28.17±12.69	0.41±0.22	5.94±10.03	14.69±20.04	24.06±24.76	29.38±33.58	21.88±25.29
81-90	23.33±10.0	0.35±0.15	—	—	41.25±41.56	32.50±39.61	1.25± 2.17
91-100	35.00±15.00	0.95±0.55	15.25±15.24	3.75± 6.50	12.50±21.65	62.25±37.95	6.25±10.83
101-110	16.67±0	0.50±0	1.00±0	—	94.00±0	—	5.00±0

distribution of the relative gut volume which connotes that the carapace width is not perfectly regulative of the parameter has been presented in the form of a curve along with the standard errors of the modal values. Fig. 3 shows a relationship between the carapace width and gut volume and serves two purposes. First, the harmony between the measured values and calculated values has been shown to indicate the precise exponential nature in the relationship of the parameters involved. Secondly, the linearity in the correlation between carapace width and gut volume is shown to be direct. The food composition in different specimens is presented in Fig. 4. The figure not only shows the relative proportions in the availability of gut contents but also indicates the changing preference for food at different growth stages.

Generally, the gut plus food volume comprised a minimum of 0.75±0.15 ml and a maximum of 3.00±0 ml. Correspondingly the calculated and measured gut volumes were 0.35±0.01 ml., 0.35±0.08 ml (minimum) and 2.28±0 ml., 2.50±0 ml. (maximum). The guts of the crabs were filled to 16.67±0 to 52.80±9.92%. While the highest percentages of fullness were encountered with smaller size groups, the lowest percentage was recorded in the highest size group. Food composition was dependent on the size group. In all, four major types of dietary ingredients and a significant percentage of unidentified and degenerated tissue matter were isolated and are discussed.

DISCUSSION

A large amount of work has been done on the food and feeding habits of *S. serrata*. Arriola (1940) has reported on a multidietary habit, indicating that the crab may occupy a wide niche having access to different food

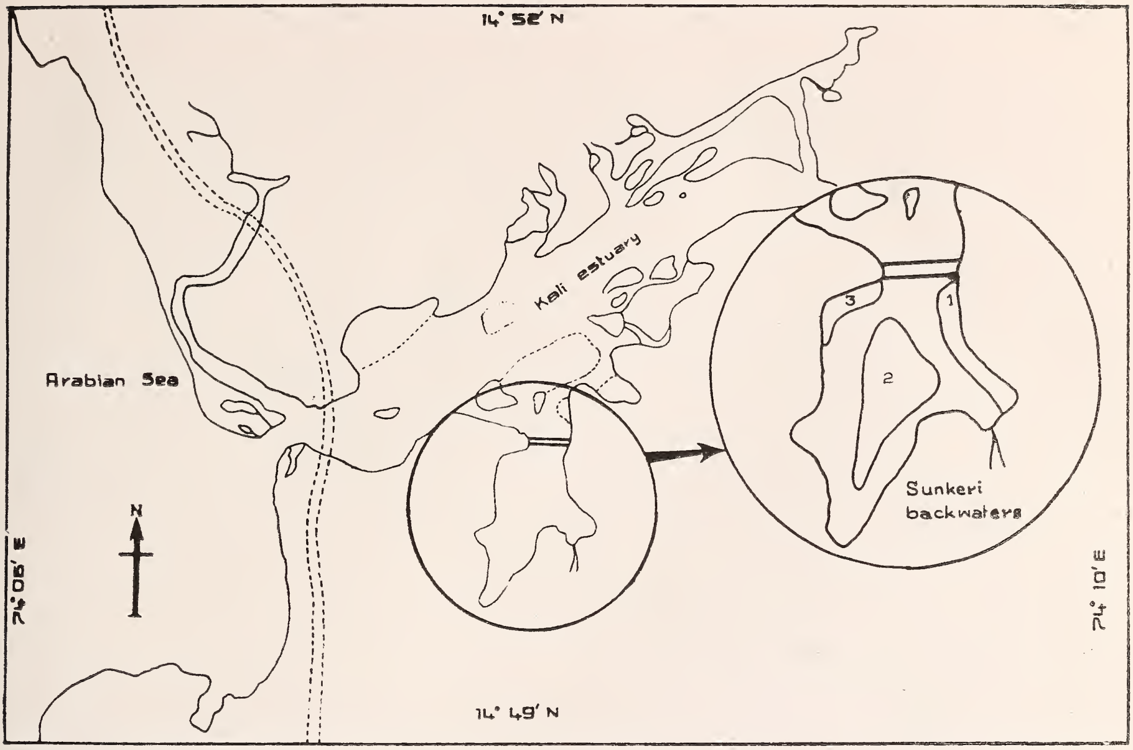

Fig. 1. Map showing the study area. (Feeding habitats located). 1. Mangroves. 2. Axial depressions. 3. Backwater bunds.

ingredients through different devouring mechanisms. Atkinson (1971) and Duplessis (1971) had tried to rear the crab on artificial diets. The investigations on physiological aspects of digestion of the crab by Barker & Gibbson (1978) and natural food and foregut clearance rate by Hill (1976) have revealed much information on the feeding ecology of *S. serrata.* But there exists a precise relationship between the foregut volume and the size (carapace width), suggesting the digestive capability of the crab, which is least explored and explained in the past.

The foregut volume:

The foregut volume was directly proportional to the size of the crab. Both the calculated and measured values of gut volume were related to an increasing carapace width (Fig. 2). The amount of increase in gut volume in the lower size groups (51-60 mm) was very gradual and small, while the increase in the higher groups, especially between 91 and 110 mm was large. This suggests a probable geometric increase in the amount of ingestion with increase in the carapace width of higher size groups. The values of gut volume given against size groups in Table 2 also infer such a relationship. The size group 41-50 mm showed a gut volume of 0.35±0.08 ml. But the group 101-110 mm, which was little more in size than double of the former, showed a gut volume (2.50 ml) which was seven times higher to that of the former. Therefore the

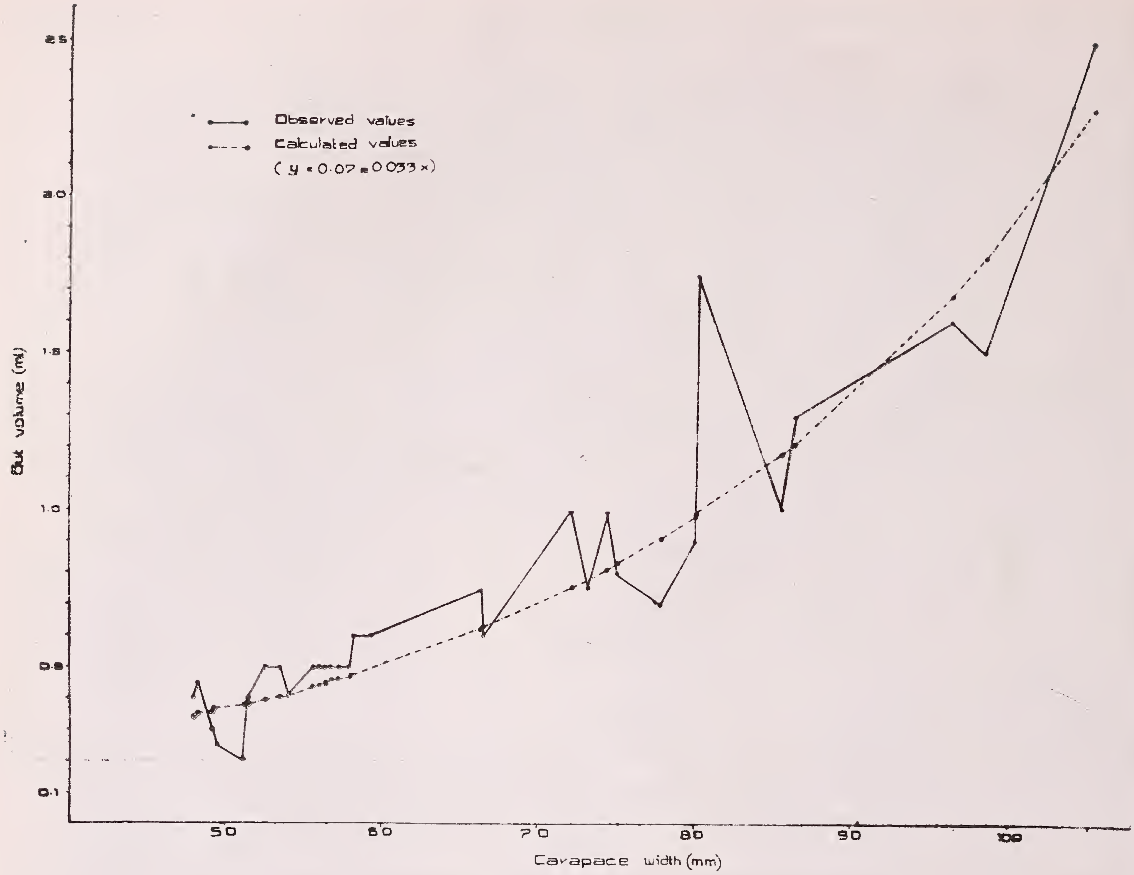

Fig. 2. Relationship of gut volume to carapace width.

greater gut volume in higher groups is suggestive of the high cheliped strength and diverse feeding habits which are all contained in the exponential proportionality. However, the relative gut volume, taken as the percentage of gut in the volume of the crab, is not in direct proportion to carapace width. This has been brought out in Fig. 2. It is seen that there is a general decline in the relative gut volume as against the carapace width, but the relationship is not perfectly linear. There have been two modes, one at 51-60 mm group and another at 81-90 mm. Moreover, the modal height of 61-70 mm group was lowest. Hence, it cannot be concluded that the relative gut volume is a function of the size in weight or volume of the whole crab. The relative gut volume varied between 0.83±0.08 and 1.36±0.35% (Table 2), and can be quite insignificant during volumetric comparisons in assessment of growth of body parts. In all, it is the actual gut volume and not the relative one that holds a predictable relationship to carapace width (Fig. 3) and also indicates the changing capability of ingestion during growth of *S. serrata*.

Food composition:

Food volume and the fullness of the gut are also reported in Table 3. But, as they are

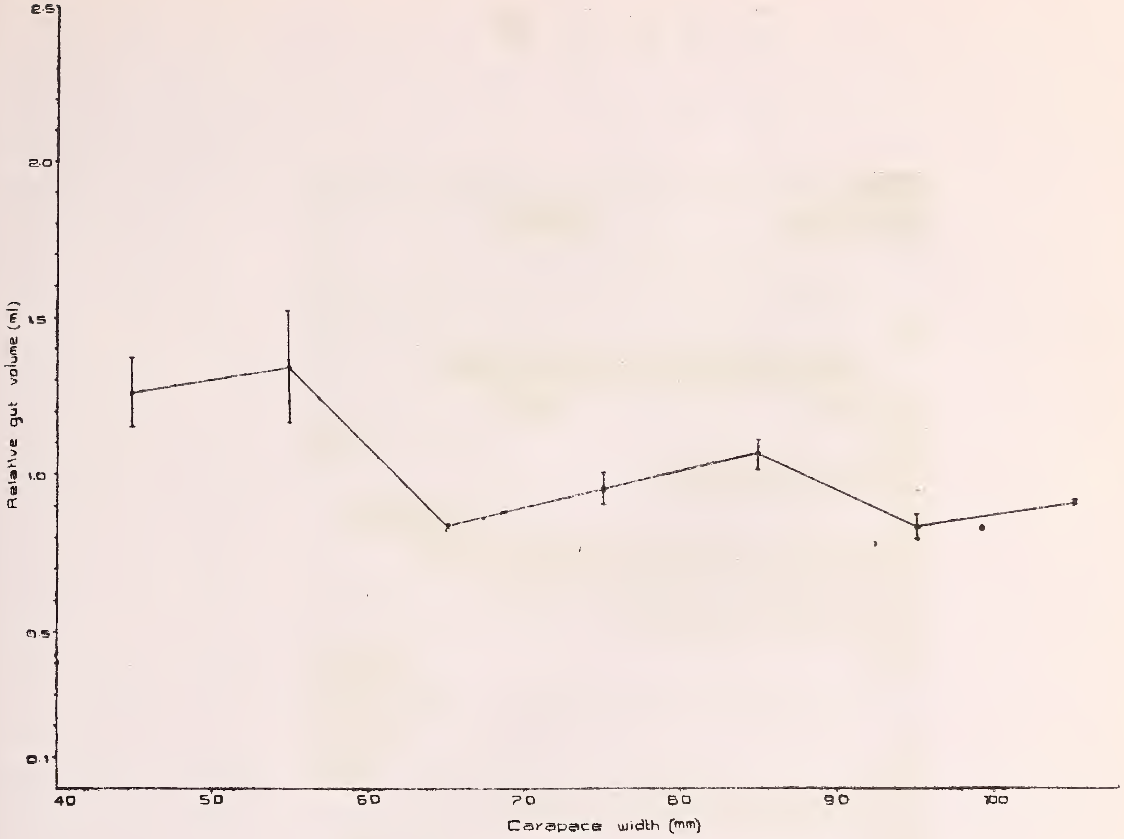

Fig. 3. Relationship of relative gut volume to carapace width.

consequential and may indicate only the availability and distribution of the food during and prior to the time of collection of crabs, they do not yield any useful information. Other significant features of stomach condition, like the food composition and its relation to size groups, are presented in Table 3 and Fig. 4.

The food in the gut was found to be in a semi-digested form even though the crabs were frozen within a short time of the collection. The availability of food from different sources in the partially digested form suggests an efficient digestive physiology (Barker & Gibbson 1978, Hill 1976), supporting its diverse distribution in these waters.

Fragments of antenna, rostrum, telson, maxilla and parts of exo- and endoskeleton that were found in the gut, helped in the identification of the food species. The food usually comprised of remains of crustacea, mollusca and fish, detritus and some unidentifiable chitinous matter. The crustacean remains in the guts of the crab were those of *Penaeus indicus, Metapenaeus dobsoni* and smaller sized *S. serrata.* Molluscan remains comprised of both gastropods and bivalves, usually *Anomia* sp., *Paphia malabarica, Meretrix casta* and *Villorita cyprinoides.* Vertebrae and some skeletal pieces of fishes whose identity was difficult to make out, formed the third part of

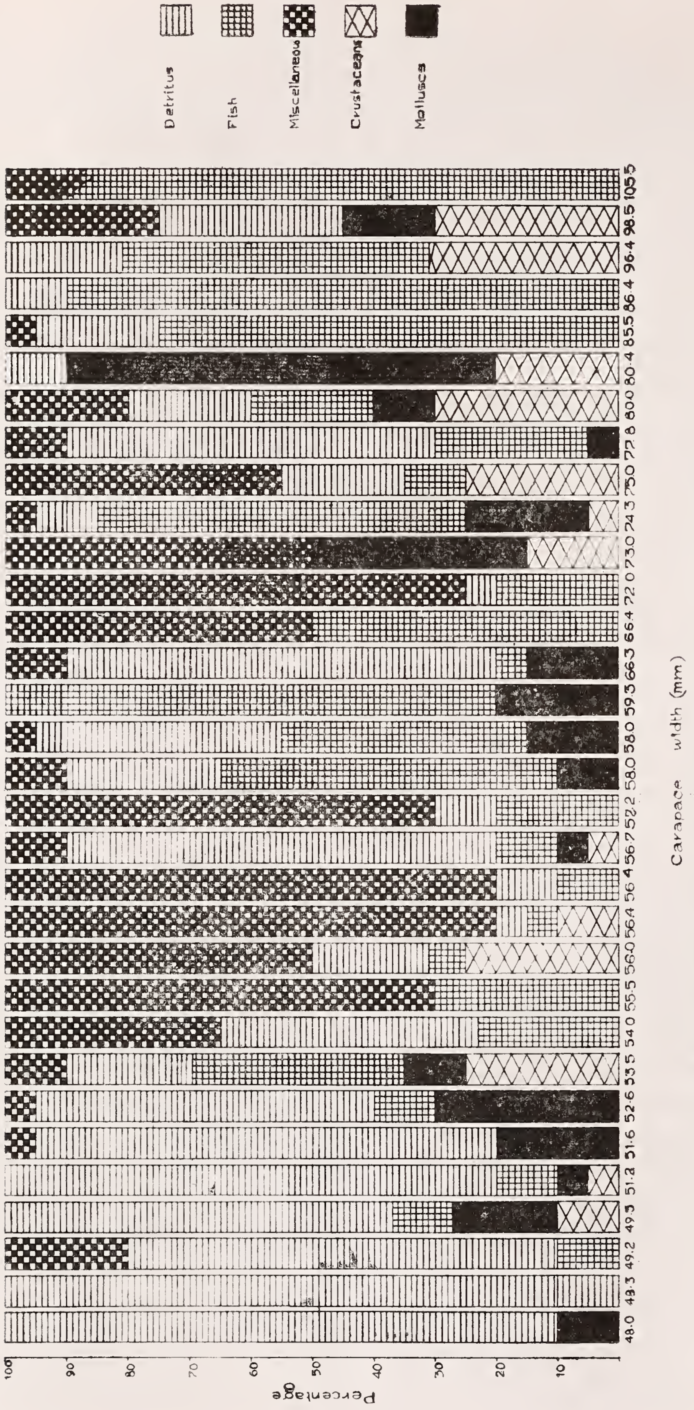

Fig. 4. Percentage food composition in different sized specimens of *S. serrata.*

the diet of the crab. Occasional occurrence of placoid scales in the gut indicated that some of the crabs might have escaped with a morsel of the elasmobranch bait used by fishermen to catch them. Detritus also occurred in considerable amounts in the guts of the crab, upholding the view of Arriola (1940) that the crab is omnivorous.

In general, the remains of crustacea, mollusca, fish and detritus varied between 1.00±0 and 15.25±15.24, 3.75±6.50 and 14.69±20.04, 6.00±4.90 and 94.00±0 and 24.50±25.24 per cent respectively (Table 3). It is seen from Table 3 that it was fish remains and detritus that formed the major portion of the diet of *S. serrata.* The food ingredients were not commonly available in all the size groups of the crabs. It was only molluscan remains and detritus that were found in the guts of the crabs of 41-50 mm group. While it was only fish remains and detritus in the guts of 81-90 mm group, the 101-110 mm group possessed only fish and crustacean remains. Unidentified tissue material was found in all guts except in those of the 41-50 mm group.

What is clear from Fig. 4 is the differential availability of dietary constituents in the guts of different sized crabs. Detritus is the major portion of food in the smaller size groups. Some of the middle sized (57.2-66.4 mm) and large crabs (more than 85.5 mm) showed a large amount of fish remains in the gut. This change in the diet certainly has a relationship with the growing size of the organism in general and increasing volume of the gut in particular. The exponential increase in the gut volume in accordance with the growth explains the need to accommodate a dietary component which exceeded very much in volume that of the detritus.

Feeding behaviour:

Some references are available regarding the feeding behaviour of *S. serrata.* Hill (1976) has discussed in brief the mode of feeding, while Walne & Dean (1972) have described the bivalve feeding as a part of an emergency feeding. Muntz *et al.* (1965) have indicated that there can be an efficient regulation of macro-invertebrate prey species by the feeding relationships of *S. serrata.* Even though such theoretical contemplation was not attempted during the present study, some aspects of the feeding behaviour were observed under laboratory conditions.

Various size groups of crab were collected from Sunkeri backwaters and were kept in different glass troughs and glass aquaria with about 3 inches of sand and nearly six inches of water as suggested by Prasad & Tampi (1953). The crabs were fed different types of food, namely oil sardine, anchovies, prawn waste and clam meat. Of these the crabs were found to be more partial towards clam meat—feeding twice a day. It was observed that most of the crabs preferred to feed during the night, although plenty of food in the form of pieces of whole clam meat was provided during the day. For most of the time, they remained fully buried in the sand with only their eyes and antennae projecting out. Hill (1976) observed that *S. serrata* remained buried during the day, emerging at sunset to feed. He further indicated (Hill 1979) that food location was by contact chemoreception using the dactyli of the walking legs, and that *S. serrata* showed preference for small crabs as prey because of their larger mass and higher energy content when compared with other prey organisms.

In the present experiment, the crabs lived for 6-7 days in all the troughs, but the survival rate was more in the aquaria where enough sand was provided. Generally, crabs died soon after moulting. When two crabs of different sizes were placed in the same aquarium, the larger one tended to be dominant and even killed and ate the smaller crab, despite the availability of clam meat. Food and water in the aquaria and glass troughs were changed twice a day. The feeding rate increased after 24 hours of acclimation of the crabs in laboratory. The crabs were aggressive during the feeding process and held their chelipeds closely against the mouth when they were not involved in feeding. Moreover, the crabs refused to feed actively in the presence of an observer or under brightly lit conditions.

There has been a debate as to whether the crabs are actively engaged in catching the prey organisms. Though Caine (1974) explained a prey-catching mechanism of another portunid crab, *Ovalipes guadulpensis*, Hill (1976) has failed to find a similarity of such technique in *S. serrata*. There was not much experimentation in this regard during the present investigation also. But, from the general field observations we can say that the crabs spend more time being mobile than in remaining buried. Their inquisitive handling of most molluscan shells while on the prowl for food suggests their continuous efforts at food collection, be it through carnivory or scavenging.

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BIRDS OF THE VISAKHAPATNAM GHATS, ANDHRA PRADESH — 2[1]

S. Dillon Ripley[2], Bruce M. Beehler[2] and K. S. R. Krishna Raju[3]

[*Continued from Vol. 84*(3): 559]

867. **Pitta brachyura brachyura** (Linnaeus).
INDIAN PITTA.

Observed at Pedevalasa on 16 October 1983.

923-928. **Hirundo daurica.**
REDRUMPED SWALLOW.

Hundreds were observed roosting on high power lines at Lankapakalu in October 1983.

948. **Lanius schach tricolor** (Hodgson).
BLACKHEADED SHRIKE.

Observed at Wangasara in October 1983.

949. **Lanius cristatus cristatus** Linnaeus.
BROWN SHRIKE.

Specimens: 1 male (t.n.e.), Jyothimamidi, 2 March 1985.

Measurements: wing 87.2, culmen 19.5, tail 84, weight 23.5.

953. **Oriolus oriolus kundoo** Sykes.
INDIAN GOLDEN ORIOLE.

Specimens: 1 immature female (o.n.e.), Wangasara, 7 March 1985.

Measurements: wing 129, bill 31, tail 79.5, weight 52.

Soft parts: iris dark brown, legs bluish grey, bill black.

958-959. **Oriolus xanthornus xanthornus** Linné
BLACKHEADED ORIOLE.

Specimens: 1 male (t.n.e.), Jyothimamidi, 25 February 1985; 1 female (o.s.e.), Wangasara, 7 March 1985.

Measurements: (male) wing 130, culmen 28.2, tail 82, weight 55; (female) wing 134, culmen 28.5, tail 82.5, weight 47.

Soft parts: (male) iris dark red, legs blue-grey, bill flesh; (female) iris dark red, legs slaty grey, bill dull rosy pink.

Taxonomy: our specimens key to this race by plumage and wing length.

Notes: Call note is a musical *dyu*!

965-966a. **Dicrurus leucophaeus** (Vieillot).
GREY DRONGO.

Mist-netted at Wangasara, 3, 6 October 1983.

Measurements: (unsexed) wing (arc) 133, 135, 140, weight 41, 42, 43.

Soft parts: (unsexed) iris pale orange, dark red, dark red-brown, gape cream-coloured.

967. **Dicrurus caerulescens caerulescens** (Linnaeus).
INDIAN WHITEBELLIED DRONGO.

Specimens: 1 female (o.n.e.), Jyothimamidi, 27 February 1985.

Measurements: wing 116, culmen 25, tail 110, weight 34.

Soft parts: iris dark red, legs black, bill black.

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971. **Dicrurus aeneus aeneus** Vieillot.

BRONZED DRONGO.

Specimens: 1 male (t.n.e.), Wangasara, 24 September 1983; 1 male (7×5 mm), 1 female (o.n.e.), Jyothimamidi, 28 February 1985; 1 male (t.e.), Lankapakalu, 12 March 1985.

Measurements: (male) wing 119 (2), 123, culmen 22, 23, 24, tail 100, —, 104.5, weight 22, 22.5, 23; (female) wing 118, culmen 22, tail 101, weight 20.

Soft parts: (all) iris dark brown, legs black, bill black.

Notes: The Wangasara specimen was netted in coffee plantation and its stomach contained ants. On 20 October 1983, at 1732 hrs., BB watched a streamside group of 8 individuals aerial hawking over the stream. One timed individual remained in the air for 95 seconds.

976-977. **Dicrurus paradiseus grandis** (Gould)/ **paradiseus** (Linnaeus).

GREATER RACKET-TAILED DRONGO.

Specimens: 2 females (o.n.e.), Jyothimamidi, 27, 28 February 1985.

Measurements: wing 158, 158.5, culmen 37, 37.5, tail (central rectrices) 322, 335, tail (outer streamers) 322, 335, weight 74, 78.

Soft parts: iris reddish brown or dark brown, legs black, bill black.

Taxonomy: By plumage our specimens key to *grandis* but by wing and tail measurements they correspond to *paradiseus.*

982. **Artamus fuscus** Vieillot.

ASHY SWALLOW-SHRIKE.

Observed at Anantagiri in March 1985.

987. **Sturnus malabaricus malabaricus** (Gmelin).

GREYHEADED MYNA.

Specimens: 1 male (t.n.e.), Jyothimamidi, 1 March 1985.

Measurements: wing 100.5, culmen 22.5, tail 57.5, weight 40.

Soft parts: iris bluish white, legs brownish yellow, bill basally mauve-blue, median area olive-green, tip orange.

1006. **Acridotheres tristis** (Linnaeus).

INDIAN MYNA.

Observed at Jyothimamidi.

1010. **Acridotheres fuscus mahrattensis** (Sykes) **fuscus** (Wagler).

SOUTHERN JUNGLE MYNA.

Specimens: 1 male (t.n.e.), Jyothimamidi, 28 February 1985, 1 male (t.n.e.), Lankapakalu, 13 March 1985.

Measurements: wing 123.5, 124, culmen 26, 28.9, tail 70, 70.5, weight 81, —.

Soft parts: iris yellow or dark brown, leg colour ochre, bill basally black, distally orange, nares and gape dull red.

Taxonomy: Variation among the Indian populations is very slight and thus it is difficult to assign our birds. Eye colour of one specimen was yellow (which would refer to northern populations).

1015, 1017. **Gracula religiosa intermedia** A. Hay.

HILL MYNA.

Specimens: 1 male (t.n.e.), 1 female (o.s.e.), Jyothimamidi, 24, 26 February 1985.

Measurements: (male) wing 158, culmen (base) 33, tail 72, weight 185; (female) wing 158, culmen 29.5, tail 69.5, weight 190.

Soft parts: (all) iris brown, legs yellow, claws black, bill reddish orange, tipped yellow, orbital skin orange-yellow.

1038. **Dendrocitta formosae himalayensis** Blyth.

EAST HIMALAYAN TREE PIE.

Specimens: 1 female (o.n.e.), Milerulu, nr. Paderu, 28 February 1981; 1 male (t.n.e.), Lankapakalu, 25 October 1983, 1 male (t.n.e.), Wangasara, 5 March 1985.

Measurements: (male) wing 143, 145.5, culmen 32.5 (2), tail 202, 207, weight 92, 74; (female) wing 142.5, culmen 33, tail 200, weight 80.

Soft parts: (male) iris dark red, legs and bill black; (female) iris dark brownish red, legs and bill black.

Taxonomy: The race *sarkari* Kinnear and Whistler, based on specimens taken in the Visakhapatnam Ghats, is not recognized, following Biswas (1963). Our material confirms this assessment, *contra* Abdulali (1980).

Notes: *D. vagabunda* was not recorded by us in our studies, although it had been recorded by the Vernay group and Abdulali.

1048-51. **Corvus splendens** (Vieillot).
HOUSE CROW.

Observed at Lammasinghi in March 1985.

1057. **Corvus macrorhynchos culminatus** Sykes.
INDIAN JUNGLE CROW.

Specimens: 1 male (t.e.), Jyothimamidi, 28 February 1985.

Measurements: wing 302, culmen (base) 64.5, tail 177.5, weight 430.

Soft parts: iris dark brown, legs and bill black.

1065. **Hemipus picatus picatus** (Sykes).
BLACKBACKED PIED FLYCATCHER-SHRIKE.

Specimens: 1 female (o.n.e.), Pedevalasa, 18 October 1983; 1 [male], Jyothimamidi, 23 February 1985.

Measurements: (male) wing 61.5, culmen 15, tail 53.5, weight 9.5; (female) wing 64, culmen 16.5, tail 55, weight 9.

Soft parts: (all) iris dark brown, bill and legs black.

Notes: The female showed wing and tail moult.

1067. **Tephrodornis virgatus pelvica** (Hodgson).
NEPAL WOOD SHRIKE.

Specimens: 2 females (o.n.e.), 1 male (testes tiny) Lankapakalu, 24 October 1983; 1 male (t.n.e.), Wangasara, 10 March 1985.

Measurements: (male) wing 118, 122.5, culmen 27.5(2), tail 79, 81, weight 33, —; (female) wing 115, 117, culmen 26.5, 27, tail 80, 84.5, weight 34.4, 38.

Soft parts: (male) iris dark brown, legs dark grey, bill black; (female) iris olive.

1070. **Tephrodornis pondicerianus pondicerianus** (Gmelin).
INDIAN WOOD SHRIKE.

Specimens: 1 female (o.n.e.), Wangasara, 5 March 1985.

Measurements: wing 83.5, culmen 21, tail 59.

Soft parts: iris pale brown, legs dark blue grey.

Notes: voice is a sweet series of upslurred notes : *chuwee wee wee wee wee* with a burry quality.

1072-1074. **Coracina novaehollandiae** (Gmelin).
LARGE CUCKOO-SHRIKE.

Observed near Chintapalli in March 1985.

1077. **Coracina melaschistos melaschistos** (Hodgson).
DARK GREY CUCKOO-SHRIKE.

Specimens: 1 female (o.n.e.), Jyothimamidi, 24 February 1985.

Measurements: wing 125, bill 19.5, tail 90, weight 36.

Soft parts: iris reddish brown, bill and legs black.

1079. **Coracina melanoptera sykesi** (Strickland).
PENINSULAR BLACKHEADED CUCKOO-SHRIKE.

Specimens: 1 [male], Jyothimamidi, 25 February 1985.

Measurements: wing 109.5, culmen 17.5, tail 80, weight 26.

Soft parts: iris brown, legs and bill black.

1083. **Pericrocotus flammeus semiruber** Whistler and Kinnear.

EAST INDIAN SCARLET MINIVET.

Specimens: 1 female (o.n.e.), Lammasinghi, 24 February 1981; 1 [male], 1 female (o.n.e.), Jyothimamidi, 27 February 1985, 1 female (o.s.e.), Wangasara, 4 March 1985.

Measurements: (male) wing 102, culmen 21, tail 98, weight 29.5; (female) wing 97, 99, 102, culmen 18.5, 19.2, 20, tail 91, 92.3, 93.5, weight 26.5, 27, 28.5.

Soft parts: (male) iris brown, legs and bill black; (female) iris dark brown, legs and bill black.

1089. **Pericrocotus roseus roseus** (Vieillot).

ROSY MINIVET.

Specimens: 1 male (t.s.e.), Wangasara, 7 March 1985; 1 female (o.n.e.), Lankapakalu, 17 March 1985.

Measurements: (male) wing 87, culmen 17, tail 83, weight 18.7; (female) wing 89.5, culmen 17, tail 85.5, weight 17.5.

Soft parts: (all) iris dark brown, bill and legs black.

1093. **Pericrocotus cinnamomeus cinnamomeus** (Linnaeus).

SOUTHERN SMALL MINIVET.

Specimens: 1 male (t.n.e.), Jyothimamidi, 27 February 1985; 1 male (t.n.e.), Wangasara, 5 March 1985.

Measurements: (male) wing 70, 71.5, culmen 12.8, 14.8, tail 68.2, 69, weight 9.5, 10.

Soft parts: (male) iris dark brown, legs and bill black.

Notes: Taken in mature coffee plantation and in remnant mixed moist deciduous forest.

1100. **Aegithina tiphia deignani** Hall.

PENINSULAR INDIAN IORA.

Specimens: 1 male (t.n.e.) Lankapakalu, 24 October 1985; 1 female (o.n.e.), Jyothimamidi, 1 March 1985; 1 male (t.e.), Wangasara, 7 March 1985.

Measurements: (male) wing 65.5, 66, culmen 16, 16.5, tail 46.2, 46.5, weight 13.2, 14; (female) wing 65, culmen 17, tail 50, weight 13. Mist-netted (unsexed) weight 14.2.

Soft parts: (male) iris dark brown, legs blue grey; (female) iris pale yellowish grey, legs bluish grey, maxilla black, mandible and tomium grey.

Notes: The Wangasara male is moulting into breeding plumage.

1104. **Chloropsis aurifrons frontalis** Pelzeln.

SOUTHERN GOLDFRONTED CHLOROPSIS.

Specimens: 1 male (t.s.e.), Jyothimamidi, 28 February 1985.

Measurements: wing 96.5, culmen 24.5, tail 67.5, weight 37.

Soft parts: iris dark brown, legs blackish grey, bill black.

1115. **Pycnonotus melanicteris flaviventris** (Tickell).

BLACK-CRESTED YELLOW BULBUL.

Specimens: 1 male (t.n.e.), Jyothimamidi, 23 February 1985; 1 male (t.s.e.), 1 female (o.e.), Wangasara, 11 March 1985.

Measurements: (male) wing 88.5, 92, culmen 15, 15.5, tail 68, 80, weight 25, 28; (female) wing 85.5, culmen 15.3, tail 74.5, weight 30. Mist-netted (unsexed) weight 24.8, 25, 25.9, 29.5.

Soft parts: (male) iris lemon yellow or whitish, legs dark brown or dark grey, bill black; (female) iris whitish, legs grey, bill black.

Notes: The two Wangasara birds show patches of orange on the belly, breast, and to a lesser extent, on the back. This may indicate the close relationship of this form with the rubythroated form from the Western Ghats and Southernmost India.

1121. **Pycnonotus jocosus emeria** (Linnaeus).
BENGAL REDWHISKERED BULBUL.

Specimens: 1 male (t.e.) Lammasinghi, 25 February 1981; 1 male (t.s.e.), Mileruleru, 27 February 1981.

Measurements: (male) wing 85, 87, culmen 18, 18.5, tail 77 (2), weight 28, 29.5. Mist-netted (unsexed) weight 20, 21.8, 22 (9), 24 (3), 25 (2), 26 (5), 26.5 (2), 27, 28 (5), 29 (5), 30 (7), 32, 32.5, 37.8.

Soft parts: (male) iris dark brown, legs and bill black.

1130. **Pycnonotus cafer wetmorei** Deignan.
ORISSA REDVENTED BULBUL.

Specimens: 1 female (o.n.e.), Lammasinghi, 25 February 1981; 1 male (t.e.), 1 female (o.n.e.), Jyothimamidi.

Measurements: (male) wing 87, 94, culmen 19.5, 20, tail 79(2), weight 29, 30; (female) wing 87.5, culmen 19, tail 75, weight 29. Mist-netted (unsexed) weight 25, 26, 27, 28 (4), 29(5), 30, 31, 32, 33, 34(5), 36(3), 37, 38.

Soft parts: (all) iris dark brown, legs and bill black.

1138. **Pycnonotus luteolus luteolus** (Lesson).
WHITEBROWED BULBUL.

Specimens: 1 male (t.n.e.), Lammasinghi, 26 October 1983.

Measurements: wing 92, culmen 20, tail 83, weight 41.5.

Soft parts: iris dark brown, legs blue-grey.
Notes: mist-netted in scrub.

1154. **Pellorneum ruficeps ruficeps** Swainson.
PENINSULAR SPOTTED BABBLER.

Specimens: 1 female (o.n.e.) Raghavendra Nagar, 1 March 1981; 1 female (o.n.e.), Pedevalasa, 18 October 1983; 2 males (t.n.e.), Jyothimamidi, 21, 24 February 1985.

Measurements: (male) wing 66, 73, culmen 18, 20, tail 59, 66, weight 26, 27.6; (female) wing 67, 69, culmen 17.8, 19, tail 59, 60, weight 24.5, 25.5. Mist-netted (unsexed) weight 22.9, 23, 24.5, 25.5 (5), 26.5 (3), 27.5, 28, 28.5, 29.5.

Soft parts: (male) iris medium brown or pale brown, legs brownish flesh, maxilla brown, mandible pinkish brown; (female) iris brown or dark brown, legs pale brown, maxilla dark brown, mandible flesh.

Taxonomy: for notes on the taxonomy of specimens from the Eastern Ghats see Abdulali (1982).

1167a. **Malacocincla abbotti krishnarajui** Ripley and Beehler.
PENINSULAR ABBOTT'S BABBLER.

Specimens: 2 males (—), Lankapakalu, 2, 3 March 1981; 1 male (t.s.e.), 4 females (o.n.e.), Pedevalasa, 14, 15, 19 October 1983; 1 male (t.e.), Lankapakalu, 12 March 1985.

Measurements: (male) wing 76.5, 80, culmen 21.5 (2), tail 48.5, 51.5, weight 26, 27.5; (female) wing 75, 77, 77.5, culmen 20.5, 21.5, 22, tail 44.5 (2), 46.5, weight 25.5, 26, 33.

Soft parts: (all) iris medium brown, legs dusky flesh, maxilla black, mandible grey.

Notes: Generic designation follows Ripley & Beehler (1985b). This population has been described as a distinct subspecies by Ripley & Beehler (1985a). Discovered by KKR and Sálim Ali at Lankapakalu, subsequently netted throughout the region in forest remnants. Birds were netted in thick vegetation in nullahs.

1173. **Pomatorhinus horsfieldi horsfieldi** Sykes.
DECCAN SCIMITAR BABBLER.

Specimens: 1 female (o.n.e.), Pedevalasa, 19 October 1983; 1 female (o.n.e.) Lammasinghi, 27 October 1983; 1 male (6×4 mm), Jyothimamidi, 22 February 1985; 1 female (o.e.), Wangasara, 8 March 1985; 1 male (t.s.e.), Lankapakalu, 15 March 1985.

Measurements: (male) wing 97, 99, culmen 32, 34.5, tail 91.5, 95, weight 40, 48; (female) wing 93(2), 96, culmen 31, 32, 32.4, tail 86.5, 93.5, 95, weight 37.5, 40.4, 47.5.

Soft parts: (male) iris dark brown, legs dark blue-grey, maxilla black basally, yellow distally, mandible yellow; (female) iris dark brown, legs greyish brown, bill blackish basally, yellow distally.

1209. **Stachyris rufifrons ambigua** (Harington).
ASSAM REDFRONTED BABBLER.

Specimens: 2 males (t.e., t.n.e.), Jyothimamidi, 27 February 1985; 1 male (t.n.e.), 1 female (o.n.e.), Wangasara, 6 March 1985.

Measurements: (male) wing 50.5, 52, 53.8, culmen 13.8, 15(2), tail 41.5, 46.5(2), weight 8, 7.5, 9.5; (female) wing 55.5, culmen 13.5, tail 49, weight 9. Mist-netted (unsexed) weight 10(4), 10.6.

Soft parts: (male) iris brownish red, dark red, legs brownish dull yellow, maxilla black, mandible mauvy-flesh; (female) iris dark red, legs dull yellow, maxilla blue-grey, basally dark pink, mandible blue-grey, basally pink.

Notes: At Wangasara the voice was recorded as : *whoot — wi wi wi wi wi wi wi wi*, soft and mellow.

1222. **Dumetia hyperythra hyperythra** (Franklin).
RUFOUSBELLIED BABBLER.

Specimens: 1 male (t.n.e.), Lammasinghi, 24 February 1981.

Measurements: wing 59, culmen 14.5, tail 60.5, weight 12. Mist-netted (unsexed) weight 12, 14.

Soft parts: iris brown, legs pinkish brown, bill slaty.

Notes: A bird netted at Wangasara on 28 September 1983 had a brood patch.

1228. **Macronous gularis rubricapilla** (Tickell).
YELLOWBREASTED BABBLER.

Specimens: 1 male (t.e.), Jyothimamidi, 23 February 1985; 1 female (o.n.e.), Wangasara, 5 March 1985; 1 male (t.s.e.), Lankapakalu, 12 March 1985.

Measurements: (male) wing 60, 60.5, culmen 15, 15.5, tail 49, 50, weight 11.6, 16.5; (female) wing 57, culmen 14, tail 49, weight 10.5. Mist-netted (unsexed) weight 12.2, 13.5, 15.6.

Soft parts: (male) iris pale tan, legs greenish brown or dusky yellow, bill pale blue-grey; (female) iris pale tan, legs greenish horn, bill blue-grey, maxilla darker.

1231. **Chrysomma sinense sinense** (Gmelin).
YELLOW-EYED BABBLER.

Specimens: 1 unsexed, Bhadrachalam, 11 March 1975; 1 female (o.n.e.), Lammasinghi, 24 February 1981; 2 males (t.n.e.), Jyothimamidi, 2 March 1985.

Measurements: (male) wing 66.5(2), culmen 15.5(2), tail 78, 89.5, weight 17, 19; (female) wing 63.5, culmen 18.8, tail 75.5, weight 18; (unsexed) wing 63, culmen 14.8, tail 77.5.

Soft parts: (male) iris pale orange or pale orange with an ochre inner ring, legs dusky yellow or ochre, foot pads ochre, nails horn, eye-lid pale orange, bill black; orbital skin yellow; (female) iris yellow, legs brownish yellow, eye-lid pink, bill black.

Notes: One of the males from Jyothimamidi is very dusky ventrally, but otherwise identical to the others.

1262. **Turdoides striatus orientalis** (Jerdon).
PENINSULAR JUNGLE BABBLER.

Specimens: 1 male (t.e.), Dumuku village, nr. Anantagiri, 23 March 1985.

Measurements: wing 97.5, culmen 22.5, tail 96.5, weight 67.

Soft parts: iris yellow, legs soiled white, bill whitish horn, tip shaded darker, gape lemon yellow.

Taxonomy: The fact that our bird is unquestionably *orientalis* is surprising, considering the distribution of the race *orissae*.

Notes: collected in open scrub; this is a "plains" species that has made its way into the man-created open habitats of the ghats.

1389. **Alcippe poioicephala brucei** Hume.
BOMBAY QUAKER BABBLER.

Specimens: 1 male (t.n.e.) Wangasara, 1 October 1983; 1 male (t.n.e.), 1 female (o.n.e.) Jyothimamidi, 27 February 1985.

Measurements: (male) wing 69, 72, culmen 16.5(2), tail 62, 62.8, weight —, 16.5; (female) wing 67.5, culmen 16, tail 64, weight 17. Mist-netted (unsexed) weight 17(4), 18(5), 19(17), 20(12), 22(1), 23(1), 24, 25, 26.

Soft parts: (all) legs brown, bill black, tomia flesh; (male) iris grey, brownish grey; (female) iris brownish grey.

Notes: The most common babbler in the region, often seen in small parties.

1407. **Muscicapa latirostris** Raffles.

BROWN FLYCATCHER.

Specimens: 1 male (t.n.e.), Wangasara, 9 March 1985; 1 female (o.n.e.), Anantagiri, 22 March 1985.

Measurements: (male) wing 66, culmen 14.2, tail 45.5, weight 11; (female) wing 68, culmen 13, tail 46.5, weight 10.

Soft parts: (male) iris dark brown, legs black, maxilla blackish, mandible dull yellow with a black tip; (female) iris dark brown, legs brownish black, maxilla black, mandible ivory with a black tip.

Notes: the female taken in late March had a deposit of subcutaneous fat.

1408. **Muscicapa muttui muttui** (Layard).
BROWNBREASTED FLYCATCHER.

Specimens: 1 female (o.n.e.), Pedevalasa, 10 October 1983; 1 female (o.n.e.), Dumuku village, nr. Anantagiri, 21 March 1985.

Measurements: (female) wing 70, 72, culmen 16, 17, tail 49(2), weight 12, —.

Soft parts: (female) iris dark brown, legs pink, or brownish flesh, maxilla dark brown with a pink tip, mandible flesh, tinged with pale brown.

Notes: The Pedevalasa specimen was taken in a patch of evergreen forest.

1412. **Muscicapa parva albicilla**(?) Pallas.
EASTERN REDBREASTED FLYCATCHER.

Specimens: 1 female (o.n.e.), Anantagiri, 20 March 1985.

Measurements: wing 67, culmen 13.2, tail 45, weight 11.

Soft parts: iris dark brown, legs and bill black.

Notes: By distribution should be *albicilla.*

1421-1422. **Muscicapa superciliaris aestigma** Gray/**superciliaris** Jerdon.
WHITEBROWED BLUE/LITTLE BLUE-AND-WHITE FLYCATCHER.

Specimens: 1 [male], Lammasinghi, 24 February 1981; 1 (unsexed), Jyothimamidi, 26 February 1985.

Measurements: (male) wing 66, culmen 13, tail 41.5, weight 7.5; (female) wing 62.5, culmen 12.5, tail 44, weight 7.5.

Soft parts: (all) iris dark brown, legs and bill black.

Taxonomy: Neither specimen shows white in the tail; in addition, the white supercilium is barely discernible.

1438. **Muscicapa tickelliae tickelliae** (Blyth).
TICKELL'S REDBREASTED BLUE FLYCATCHER.

Specimens: 1 [male] Wangasara, 25 September 1983; 1 [male] Pedevalasa, 19 October 1983; 1 male (t.n.e.) Lankapakalu, 23 October

1983; 3 males (t.n.e.), 1 female (o.n.e.) Jyothimamidi, 21, 23 February 1985.

Measurements: (male) wing 72, 72.5, 76, 77.5, 78.5, culmen 14.5, 15, 15.8, 16, 16.4, 16.8, tail 54.5 (2), 59.5, 62, 62, weight 14.4, 14.5, 14.9(2), 15(2); (female) wing 71, culmen 14.8, tail 54.5, weight 15.

Soft parts: (all) iris dark brown, legs vinaceous flesh; bill black.

Notes: The presence of this species in the Visakhapatnam Ghats stands as the most curious phenomenon that we encountered in our study. While we have too few data to conclusively unravel the mystery, here we attempt to interpret the facts we have at this point. In 1930 the Vernay expedition surveyed the Vizag Ghats and took no specimens of *M. tickelliae* (they took no *tickelliae* north of the Palkonda Hills) and yet collected a series of 16 specimens of a very similar form described as *Muscicapa poliogenys vernayi* (type from Anantagiri). This was the common form of this species-group on the Vizag ghats when they surveyed.

In measurements, the two forms are not separable, thus one must depend on plumage coloration and sexual dimorphism to determine taxon. In *tickelliae*, the adult male is entirely blue above, whereas in *poliogenys vernayi* the male is basically grey-brown above with blushes of blue on the rump and outer webs of the rectrices. In the females, *tickelliae* is virtually identical to the male *poliogenys vernayi*, and the female of the latter is entirely lacking in blue wash on any part of the upperparts (virtually identical to either sex of *M. poliogenys poliogenys*).

The remarkable fact is that no subsequent visitor to the Vizag Ghats has encountered *M. poliogenys vernayi*. Abdulali observed and identified only *tickelliae*. Price found one species in his area, which he tentatively identified as *vernayi* (but which is obviously *tickelliae* from his description). His confusion is easy to understand based on the ambiguous description in the Handbook of the amount of blue on the adult male. We have borrowed a series of *poliogenys vernayi* from the British Museum, including male and female "co-types." These make positive identifications of our material possible.

Our surveys recorded only *tickelliae*, which we encountered wherever we went. Working at Anantagiri, where the Vernay party collected three individuals of *poliogenys vernayi*, in 1985 we encountered only *tickelliae* (specimens of which we mist-netted and released).

We can offer two speculative explanations: either (1) *tickelliae* populations have moved northward through the ghats and displaced *poliogenys vernayi* (which is now extinct or else remains in remnant pockets further north). Or (2) the population *'vernayi'* was no more than a hybrid population in a zone of overlap between *tickelliae* and *poliogenys*. Genetic swamping by *tickelliae* in the last fifty years has nearly extinguished the remaining *poliogenys* genes. This second explanation has a major flaw but also has some support. The flaw is: why don't *tickelliae* and *poliogenys* hybridize elsewhere where they overlap (e.g. in the Northeast or Burma)? Support of the latter hypothesis comes in the form of comparison of study skins of the two species from peninsular India. In the far South, *tickelliae* is richer and brighter with deeper blue and richer underparts. The specimens we collected of *tickelliae* in the Ghats are much paler than many of these southern birds. Is this because of introgression? Specimens of *poliogenys* collected by the senior author from north of the Mahanadi, in Orissa, in 1978, are identifiable as *poliogenys poliogenys* (no trace of blue on upperparts, male like female). We suggest it is possible that the two species overlap in a small zone between the Godavari and Mahanadi, and that since 1930, the influence of *tickelliae* in this hybridization has become dominant. More data are needed to test these two hypotheses. Certainly, something unusual is occurring with the population that occupies the Vizag Ghats.

1440. **Muscicapa rubeculoides rubeculoides** (Vigors).

BLUETHROATED FLYCATCHER

Specimens: 1 male (t.n.e.), Wangasara, 11 March 1985; 1 female (o.n.e.), Dumuku village, nr. Anantagiri, 20 March 1985.

Measurements: (male) wing 68, culmen damaged, tail 50.2, weight 14.5; (female) wing 69, culmen 14, tail 51, weight 13.5.

Soft parts: (all) iris dark brown, bill black; (male) legs black; (female) legs mauve brown.

1445. **Muscicapa thalassina thalassina** Swainson.

VERDITER FLYCATCHER.

Specimens: 1 female (o.n.e.), Jyothimamidi, 2 March 1985; 1 male (t.n.e.), Wangasara, 7 March 1985.

Measurements: (male) wing 80, culmen 13, tail 66, weight 20.8; (female) wing 83.5, culmen 12, tail 64, weight 19.5.

Soft parts: (all) iris dark brown, legs and bill black.

Notes: the male had heavy fat deposition.

1448. **Culicicapa ceylonensis calochrysea** Oberholser.

NORTHERN GREYHEADED FLYCATCHER.

Specimens: 1 female (o.n.e.), Jyothimamidi, 23 February 1985.

Measurements: wing 65.5, culmen 14, tail 51, weight 8. Mist-netted (unsexed) weight 7(2).

Soft parts: iris dark brown, legs yellowish brown, maxilla brown, mandible pinkish flesh.

Notes: lores, eyebrow, and nape with white spotting caused by partial albinism.

1451-1453. **Rhipidura aureola.**

WHITEBROWED FANTAIL FLYCATCHER.

Mist-netted in a teak plantation at Wangasara, 3 October 1983.

Measurements: (unsexed) weight 10.6.

1459. **Rhipidura albicollis vernayi** (Blyth).

DANDAKARANYA WHITESPOTTED FANTAIL FLYCATCHER.

Specimens: 2 males (t.e.), Wangasara, 10 March 1985.

Measurements: (male) wing 74, 76 culmen 14.6, 15, tail 88, 90.5, weight 7.5, 9.5.

Soft parts: (male) iris dark brown, legs dark grey, black, bill black.

1461. **Terpsiphone paradisi paradisi** (Linnaeus).

PENINSULAR INDIAN PARADISE FLYCATCHER.

Specimens: 2 males (t.n.e.), Jyothimamidi, 22, 25 February 1985.

Measurements: (male) wing 96, 96.5, culmen 22.5, 25.2, tail (outer) 109, 110, tail streamers 285, 360, weight 15.5, 16.

Soft parts: iris dark brown, legs dark grey or dark blue grey, eye-ring cobalt blue or blue, bill dark blue-grey.

Notes: The male collected 22 February is in rufous-backed plumage, while the other shows the fully adult white-backed plumage.

1465. **Hypothymis azurea styani** (Hartlaub).

INDIAN BLACKNAPED MONARCH FLYCATCHER.

Specimens: 1 [female], Wangasara, 26 September, 1983; 1 (—), Pedevalasa, 17 October 1983; 1 [female], Jyothimamidi, 21 February 1985; 2 males (t.n.e.), 1 female (o.n.e.), Jyothimamidi, 21, 24 February 1985.

Measurements: (male) wing 72.5, 73, 73.5, culmen 15, 16, 16.5, tail 68(2), 68.5, weight 9, 10.4, —; (female) wing 68, culmen 15.5, tail 66, weight 8.5; (unsexed) wing 67, 72, culmen 14.8; 15.6, tail 64(2), weight 9.7, 10. Mist-netted [male] weight 9.5, 10, 10.5(2), 11, 11.5(2), 12.5; [female] weight 9, 9.7, 10, 10.2, 10.6.

Soft parts: (male) iris dark grey-brown, legs and bill black; (female) iris brown, bill and legs black; (unsexed) iris dark brown or very dark brown, legs blue-grey.

1501. **Prinia rufescens.**

RUFOUS WREN-WARBLER.

Well observed in coffee plantation at Lankapakalu on 24 October 1983.

1504. **Prinia hodgsoni albogularis** Walden.

SOUTHERN ASHY-GREY WREN-WARBLER.

Specimens: 1 male (t.n.e.), Mileruleru, 28 February 1981.

Measurements: wing 48, culmen 11.5, tail 46.5, weight 5. Mist-netted (unsexed) weight 6.

Soft parts: iris dark brown, legs brown, bill black.

1517. **Prinia socialis socialis** Sykes.

SOUTHERN ASHY WREN-WARBLER.

Specimens: 1 male (—), Upper Sileru, 19 March 1975; 1 male (t.n.e.), Lammasinghi, 24 March 1981.

Measurements: wing 49, 52, culmen 14, 15.5, tail 55.5, 59, weight 6.8, —.

Soft parts: iris pale brown, legs pale brown, bill black.

1521. **Prinia sylvatica sylvatica** Jerdon.

PENINSULAR JUNGLE WREN-WARBLER.

Specimens: 1 female (—), Sapparla, 19 March 1975.

Measurements: wing 55, culmen 15.5, tail 63.

Taxonomy: does not appear to be referable to *mahendrae*, as the back is plain brown, without rufous.

1536. **Orthotomus sutorius patia** Hodgson.

BENGAL TAILOR BIRD.

Specimens: 1 male (t.n.e.), Wangasara, 4 March 1985.

Measurements: wing 50.5, culmen 15.5, tail 38, weight 8.25. Mist-netted (unsexed) weight 7, 7.5(2), 7.9, 8.8, 9(2), 9.4, 9.5.

Soft parts: iris dull brownish yellow, legs pinkish fresh, maxilla dark brown, mandible pinkish horn.

1556. **Acrocephalus dumetorum** Blyth.

BLYTH'S REED WARBLER.

Specimens: 1 male (t.n.e.), Lammasinghi, 25 February 1981, 1 male (t.n.e.), Wangasara, 6 March 1985, 1 female (o.n.e.) Lankapakalu, 15 March 1985.

Measurements: (male) wing 60, 64, culmen 18(2), tail 49, 50, weight 9, 10.5; (female) wing 63, culmen 16.8, tail 48.

Soft parts: (male) iris earthy brown or dark brown, legs dark olive brown or dull greenish grey, maxilla dark olive brown or blackish horn, mandible brown or yellowish brown; (female) iris olive brown, legs pale greyish brown, maxilla dark brown, mandible pale flesh, mouth greyish yellow.

1563. **Hippolais caligata rama** (Sykes).

INDIAN BOOTED TREE WARBLER.

Specimens: 1 female (o.n.e.) Kallimedu, Bhadrachalam, 11 March 1975.

Measurements: wing 61, culmen 15.5, tail 47.5, weight 8.

Soft parts: iris brown.

1603. **Phylloscopus trochiloides ludlowi** Whistler.

BALTISTAN GREENISH LEAF WARBLER.

Specimens: 1 (unsexed), Pedevalasa, 16 October 1983, 2 females (o.n.e.), Jyothimamidi, 23, 26 February 1985; 2 males (t.n.e.), 1 (unsexed), Wangasara, 7, 10 March 1985.

Measurements: (male) wing 62, 65, culmen 12, 12.3, tail 47, 52, weight 7.5(2); (female) wing 57, 58, culmen 12.5, 12.8, tail 42, 44.5, weight 6.5, 7; (unsexed) wing 65, 67, culmen 14.9, —, tail 45, 46.5, weight 7.5, —.

Soft parts: (male) iris dark brown, legs greyish brown or blackish brown, maxilla brown, mandible dull yellow with a brown tip; (female) iris dark brown, legs greenish grey or brown, maxilla brown or black, mandible dusky yellow or pale horn; (unsexed) wing dark brown, legs greyish brown, maxilla brown, mandible dull yellow with a brown tip.

Notes: Voice is a perky, disyllabic *cheeyur*! or *cheelip*! reminiscent of call of the North American Pine Siskin *Carduelis pinus*.

1606. **Phylloscopus occipitalis occipitalis** (Blyth).

LARGE CROWNED LEAF WARBLER.

Specimens: 2 males (t.n.e.), Jyothimamidi, 27 February 1985; 1 male (t.n.e.), Wangasara, 7 March 1985.

Measurements: (male) wing 61, 67, 71, culmen 10.8, 13.8, 14.8, tail 41.8, 47.5, 51.2, weight 7.25, 8.25, 9.7.

Soft parts: iris brown or dark brown, legs brown or corn yellow, maxilla dark olive brown or dark brown, mandible brown.

1615. **Seicercus burkii burkii** (Burton).

EASTERN BLACKBROWED FLYCATCHER-WARBLER.

Specimens: 1 male (t.n.e.) Raghavendra Nagar, 1 March 1981; 1 male (t.n.e.) Wangasara, 8 March 1985.

Measurements: (male) wing 58, 63, culmen 11.8, 12.5, tail 41.8, 43.2, weight 7, 7.8.

Soft parts: iris dark brown or very dark brown, legs pale brown or yellowish brown, maxilla dark brown, with pale tomia and tip, mandible flesh or dull pinkish ivory.

Taxonomy: underparts identical to *burkii*, upperparts slightly more yellow-green, less olive.

1643. **Erithacus calliope** (Pallas).

RUBYTHROAT.

Specimens: 1 female (o.n.e.), Jyothimamidi, 1 March 1985; 1 female (o.n.e.), Wangasara, 8 March 1985.

Measurements: (female) wing 75.5, 76, culmen 16.5, 16.6, tail 55, 59.5, weight 18, 18.5.

Soft parts: (female) iris dark brown, legs brown or dusky brown, bill black, base of mandible grey or bill dark greyish brown, basally dull grey.

Taxonomy: The Jyothimamidi specimen is in plain plumage; that from Wangasara shows a light wash of pink in the throat.

1650, 1651. **Erithacus brunneus** (Hodgson).

INDIAN BLUE CHAT.

Specimens: 3 males (t.n.e.), 1 immature male, 1 [male], 1 female (ova tiny), 2 (unsexed), Pedevalasa, 15, 16, 17 October 1983; 1 male (t.n.e.), 1 immature male (—), 1 female (o.n.e.), Jyothimamidi, 24, 27 February 1985.

Measurements: (male) wing 74, 75.5(2), 76, 77.5, culmen 14.5, 14.8(2), 15, 16.2, tail 45.5, 46.5, 47(2), 49, weight 15.8, 16, 16.5, 18.5(2); (female) wing 72.5, 77, culmen 14.8, 16.8, tail 42.8, 44, weight 17(2); (unsexed) wing 74(2), culmen 13.9, 14.8, tail 44.5, 45, weight 13.2, 13.6; (immature male) wing 75, 75.4, culmen 15, 15.5, tail 43.5, 47.5, weight 14, 16.

Soft parts: (all) iris dark brown; (male) legs plumbeous pink, bill dark vinaceous grey or blackish brown; (female) legs pale brown, maxilla blackish brown, mandible pale brown; (immature male) legs pinkish flesh, bill pinkish grey.

Notes: The large series in October and February indicates the likelihood that there is a wintering population in the Eastern Ghats.

The birds showed no fat deposition. The Vernay Expedition collected this species in northern Andhra Pradesh and Orissa in late March and April (latest 24 April). These latter records showed fat depositions and apparently were about to migrate.

The male shows an intermediate plumage, presumably worn by the first-year birds. It is dull slaty blue above, while the underparts are like the female except they show more rich buff-tan on breast and flanks; bill pinkish grey.

1661-1663. **Copsychus saularis** (Linnaeus).

MAGPIE-ROBIN.

Observed at Wangasara in October 1983 and March 1985.

1667. **Copsychus malabaricus indicus** (Baker).

INDIAN SHAMA.

Specimens: 2 males (t.n.e.), 1 female (o.n.e.), Jyothimamidi, 22 February 1985.

Measurements: (male) wing 91, 98, culmen 19(2), tail 139, 154, weight 26.5, 29; (female) wing 88, culmen 19, tail 112, weight 26. Mist-netted weights [male] 30(2), 31.5, 32(2), 33, 35; [female] 25.5, 28.5, 29, 30.

Soft parts: (male) iris dark grey brown or dark brown, legs flesh, bill black; (female) iris dark brown, legs pinkish, bill black.

1701. **Saxicola caprata burmanica** Baker.

BURMESE PIED BUSH CHAT.

Specimens: 1 [male], Lankapakalu, 17 March 1985.

Measurements: wing 72, culmen 15.5, tail 49, weight 15.5.

Soft parts: iris dark brown, legs and bill black.

1723. **Monticola cinclorhynchus** (Vigors).

BLUEHEADED ROCK THRUSH.

Specimens: 1 male (t.n.e.), Lankapakalu, 1 male (t.n.e.); 1 female (o.n.e.), Anantagiri, 20 March 1984.

Measurements: (male) wing 104, 106, culmen 24.5(2), tail 66, 70.5, weight 35, 36.5; (female) wing 108, culmen 24, tail 66.5, weight 39.

Soft parts: (male) iris dark grey-brown or dark brown, legs brown, or anteriorly grey, posteriorly, and pads yellow, maxilla black, mandible distally black, base and tomia yellowish brown; (female) iris dark brown, legs brown, bill as in male.

Notes: The Anantagiri male showed large fat deposits.

1728. **Myiophonus horsfieldi** (Vigors).

MALABAR WHISTLING THRUSH.

Observed at Lankapakalu in 1983 by Sálim Ali and Shahid Ali. Observed below Dumuku village, nr. Anantagiri, in 1985.

Notes: Both observations were made of birds in stream gorges.

1731. **Zoothera wardii** (Blyth).

PIED GROUND THRUSH.

Specimens: 1 male (t.n.e.), 1 female (ova granular), Pedevalasa, 15, 17 October 1983.

Measurements: (male) wing 120, culmen 26.5, tail 72, weight 69; (female) wing 110, culmen 25.5, tail 68.5, weight 57.

Soft parts: (male) iris dark brown, legs and bill yellow; (female) iris dark grey-brown, legs dirty yellow and pink.

Notes: testes of the male were small and black.

1734. **Zoothera citrina cyanotis** (Jardine and Selby).

WHITETHROATED GROUND THRUSH.

Specimens: 1 female (o.n.e.), Wangasara, 24 September 1983; 1 male (t.n.e.), Lankapakalu, 22 October 1983; 1 male (t.n.e.), Lammasinghi, 26 October 1983; 2 males (t.n.e.), Jyothimamidi, 23, 24 February 1985.

Measurements: (male) wing 105, 106.5,

107, 111. culmen 23(2), 23.3, 24, tail 64(2), 67, 67.5, weight 35(2), 49, —; (female) wing 109, culmen 23, tail 72, weight 57. Mist-netted (unsexed) weight 55(3), 57(2), 59(2), 60(3).

Soft parts: (male) iris dark brown or clay brown, legs fleshy or fleshy brown, bill black; (female) iris grey-brown.

1741-1744. **Zoothera dauma** (Latham).
SCALY THRUSH.

Observed at Pedevalasa on 19 October 1985. The bird was observed on the ground in the forest interior. Probably a winter migrant of the nominate race.

1753. **Turdus merula nigropileus** (Lafresnaye).
BLACKCAPPED BLACKBIRD.

Specimens: 1 (unsexed), Wangasara, 25 September 1983; 1 female (o.n.e.), Lammasinghi, 27 October 1985; 1 female (o.n.e.), Jyothimamidi, 23 February 1985; 2 males (t.n.e.), Wangasara, 9 March 1985.

Measurements: (male) wing 119, 124, culmen 26.5, 28, tail 87, 88.5, weight 71, 75; (female) wing 116.5, 124, culmen 25, 26.5, tail 79.5, 85.5, weight 66, 72; (unsexed) wing 115, culmen 24.5, tail 84.5, weight 80.

Soft parts: (all) iris dark brown, bill dusky yellow; (male) bill orange with ivory tip, gape yellow, eye-ring yellow; (female) bill dusky orange or dusky yellow.

Taxonomy: Whistler and Kinnear named the blackbirds from the Eastern Ghats *spencei*, based on plumage characters. Comparison of our series with topotypical *nigropileus* shows there are no consistent mensural or plumage characters to separate the two populations with confidence. We suggest combining the form *spencei* with *nigropileus*.

1763. **Turdus ruficollis atrogularis** Jarocki.
BLACKTHROATED THRUSH.

Specimens: 1 female (o.e.), Dumuku village, nr. Anantagiri, 20 March 1985.

Measurements: wing 120, culmen 23, tail 74.5, weight 72.

Soft parts: iris dark brown, legs brown, bill warm brown, gape pale brown.

Notes: This is a first record for Andhra Pradesh. The bird had large fat deposits.

1810. **Parus xanthogenys aplonotus** Blyth.
CENTRAL INDIAN YELLOWCHEEKED TIT.

Specimens: 2 male (t.n.e.), 1 female (o.n.e.), Wangasara, 12 October 1983, 4, 7 March 1985.

Measurements: (male) wing 70, 74, culmen 12.5, 13, tail 50, 52, weight 14.8, 16.5; (female) wing 70, culmen 13, tail 49, weight 16. Mist-netted weights [male] 16, [female] 15.5, [unsexed] 14.4, 15, 15.5, 16(3), 16.3, 17, 17.5(2), 18.4, 19(4).

1831. **Sitta castanea prateri** Whistler and Kinnear.
EASTERN GHATS CHESTNUTBELLIED NUTHATCH.

Specimens: 1 male (t.s.e.), Lammasinghi, 25 February 1981; 2 males (t.s.e., t.n.e.), 1 female (o.e.), Wangasara, 5, 10 March 1985.

Measurements: (male) wing 80, 83(2), culmen 21, 22, 22.2, tail 35.5, 38, 41, weight 14, 14.5, 16.3; (female) wing 77, culmen 20.5, tail 38, weight 12. Mist-netted (unsexed) weight 15.6, 15.8(2), 17, 17.5, 18.2.

Soft parts: (male) iris dark brown, legs black, maxilla black, tomia basally grey, mandible black basally grey; (female) iris dark brown, legs greyish brown, bill as for male.

1838. **Sitta frontalis frontalis** Swainson.
VELVETFRONTED NUTHATCH.

Specimens: 1 female (o.n.e.), Lankapakalu, 20 October 1983; 1 male (testis 2 × 1 mm), Wangasara, 25 September 1983.

Measurements: (male) wing 75.5, culmen 15, tail 41, weight 13; (female) wing 75, culmen 15, tail 42, weight 13.4. Mist-netted (unsexed) weight 13(2), 13.1, 13.4.

Soft parts: (all) iris yellow; (female) legs brown, bill orange-red.

1874. **Motacilla indica** Gmelin.

FOREST WAGTAIL.

A single specimen was mist-netted at Wangasara on 26 September 1983.

Measurements: (unsexed) weight 18.3.

1884. **Motacilla cinerea** Tunstall.

GREY WAGTAIL.

Mist-netted at Wangasara, 24 September 1983.

Measurements: (unsexed) weight 15 g.

1892-1894. **Dicaeum agile agile** (Tickell).

INDIAN THICKBILLED FLOWERPECKER.

Specimens: 1 male (t.e.), Lammasinghi, 24 February 1981; 1 female (o.n.e.), Wangasara, 8 March 1985.

Measurements: (male) wing 61.5, culmen 9, tail 24, weight 9.5; (female) wing 57, culmen 9.6, tail 25, weight 8.5.

Soft parts: (all) iris orange-red, legs black: (male) bill dark grey; (female) maxilla black, mandible grey.

Notes: The Lammasinghi bird had 5 seeds in the gut. We observed a male feeding in *Loranthus*. At one point, while perched parallel to the branch and facing the trunk, this bird squatted and passed a seed from which most of the fruit pericarp had been abraded. This seed, along with an attached string of mucous, was deposited onto the branch, and a ribbon of the gluey substance was spread with the bird twitching its tail in a sort of brush-work motion. Past studies show that the mucous dries quickly around the seed, attaching it firmly onto the branch, where it can germinate. This process helps to spread the parasitic plant over the host tree, quite often a peepul or banyan (*Ficus* sp.). Whether the organic material (mucous) contains nutrients as well as an adhesive substance is unknown.

1899. **Dicaeum erythrorhynchos erythrorhynchos** (Latham).

TICKELL'S FLOWERPECKER.

Specimens: 1 male (t.s.e.), Lammasinghi, 24 February 1981; 2 males (t.e.), Wangasara, 9, 10 March 1985.

Measurements: (male) wing 45, 49, 50, culmen 10, 10.4, 10.5, tail 20, 24, 24.5, weight 5, 6.3, 6.5.

Soft parts: (male) iris dark brown, legs slaty or dark grey, maxilla (a) dark brown, tomia flesh, (b) dark flesh, (c) horn, mandible (a-b) flesh, (c) greyish flesh.

Notes: voice is a single *ijjt* note in flight.

1906. **Anthreptes singalensis** (Gmelin).

RUBYCHEEK.

A single adult male was observed twice (by BB) in a nullah foraging flock at Pedevalasa, 18 October 1983.

Notes: The adult male was observed in the canopy; it called incessantly, giving a sweet high note every 1-2 seconds. The bird was easy to locate because of its vocalizations.

1907. **Nectarinia zeylonica sola** (Vieillot).

INDIAN PURPLERUMPED SUNBIRD.

Specimens: 1 male (t.e.), Wangasara, 4 March 1985.

Measurements: wing 56, culmen 18.3, tail 32, weight 7.5. Mist-netted [male] weight 7.5, [female] weight 8.5.

Soft parts: (male) iris red, legs and bill black.

1917. **Nectarinia asiatica asiatica** (Latham).

INDIAN PURPLE SUNBIRD.

Specimens: 1 male (t.e.), Jyothimamidi, 24 February 1985; 1 female (o.s.e.), Wangasara, 4 March 1985; 1 male (t.e.), Dumuku village, nr. Anantagiri, 19 March 1985.

Measurements: (male) wing 53.5, 55, culmen 20, 20.5, tail 31.5, 33, weight 7, 8.5; (female) wing 53.5, culmen 18, tail 28.7, weight 7.5.

Soft parts: (all) legs and bill black; (male) iris dark brown; (female) iris clay-coloured.

1927. **Aethopyga siparaja** (Raffles).
INDIAN YELLOWBACKED SUNBIRD.

Observed at Jyothimamidi in February 1985, and at Lankapakalu in March 1985.

1931. **Arachnothera longirostris longirostris** (Latham).
LITTLE SPIDERHUNTER.

Specimens: 1 female (o.n.e.) Raghavendra Nagar, 1 March 1981; 1 male (t.n.e.), 1 (unsexed), Pedevalasa, 15, 17 October 1983; I male (t.s.e.), Jyothimamidi, 22 February 1985.

Measurements: (male) wing 67, 69.5, culmen 34.8, 34.9, tail 39.5, 42.5, weight 11.8, 13.1; (female) wing 63, culmen 32.2, tail 34, weight 8; (unsexed) wing 60.5, culmen 32.3, tail 37.5, weight 10.9.

Soft parts: (all) iris dark brown, bill black; (male) legs blue-grey, (female) legs grey-black.

1934. **Zosterops palpebrosa salimalii** Whistler.
ANDHRA WHITE-EYE.

Specimens: 1 male (t.e.), Raghavendra Nagar, 1 March 1981; 1 male (t.e.), Jyothimamidi, 1 March 1985; 1 male (t.s.e.), Wangasara, 7 March 1985.

Measurements: (male) wing 56, 57(2), culmen 12.8, 12.9, 13, tail 36.8, 38.7, 40, weight 7.5(2), 8. Mist-netted (unsexed) 6(2), 9, 9.5(2), 9.2, 8.4.

Soft parts: (male) iris dark brown, dull ochre, legs black or slaty grey, pads of feet grey, bill black basally grey or entirely black.

Taxonomy: All three specimens show the faint yellow midline stripe on the belly.

1938. **Passer domesticus indicus** Jardine & Selby.
INDIAN HOUSE SPARROW.

Specimens: 2 males (t.e.), Lammasinghi, 6 March 1985.

Measurements: wing 73.5, 76.5, culmen 13.2, 13.4, tail 50.5, 52.5, weight 22.5, 23.5.

Soft parts: iris dark brown, legs dusky flesh, bill black.

Notes: This species has apparently lived side-by-side with *P. montanus* at Lammasinghi, and now seems to have displaced the less common congener. In our search for *montanus* at Lammasinghi in March 1985 we found none.

1942. **Passer montanus malaccensis** Dubois.
MALAY TREE SPARROW.

Specimens: 1 male (t.s.e.), Lammasinghi, 29 March 1972.

Measurements: wing 68, culmen 12.5, tail 47.2, weight 22.

Soft parts: iris dark hazel, legs pale flesh, bill black.

Notes: The only records of this species from the Peninsula are from Lammasinghi, Bussalkort, and Solabum (Price 1979). It is possible that the small resident colony has died out, as all subsequent observations have failed to produce any positive sightings.

1948-1949. **Petronia xanthocollis** (Burton).
YELLOWTHROATED SPARROW.

Observed at Lammasinghi in February 1981 and Jyothimamidi in February 1985. Individuals were foraging at a flowering Simul tree.

1965. **Estrilda formosa** (Latham).
GREEN MUNIA.

1 [female], Sapparla, 19 March 1975.

Measurements: wing 47.5, culmen 10.5, tail 33.5.

1974-1975. **Lonchura punctulata** (Linnaeus).
SPOTTED MUNIA.

Mist-netted at Wangasara on 24 and 27 September 1983.

1968. **Lonchura striata striata** (Linnaeus).
SOUTHERN WHITEBACKED MUNIA.

Specimens: 1 male (t.n.e.), Wangasara, 12 October 1983; 1 male (t.n.e.), 1 (unsexed), Dumuku village, nr. Anantagiri, 21 March 1985.

Measurements: (male) wing 52, 54, culmen 12, 12.2, tail 26, 32, weight 12(2); (unsexed) wing 51.5, culmen 11.5, tail 31.5, weight 10.

Soft parts: (male) iris dark brown, legs grey-blue, maxilla black, mandible blue-black, eye-skin grey-blue.

1971, 1972. **Lonchura kelaarti jerdoni** (Hume).
JERDON'S RUFOUSBELLIED MUNIA.

Specimens: 1 female (—), Sapparla, 19 March 1975; 2 males (t.s.e.), Lankapakalu, 23, 24 October 1983.

Measurements: (male) wing 56.5, 57, culmen 13.2, 13.8, tail 37.2, 38, weight 13, 14; (female) wing 58, culmen 13.2, tail 39.

Soft parts: (male) iris dark brown, legs blue-grey, bill blue-grey.

2011. **Carpodacus erythrinus roseatus** (Blyth).
INDIAN ROSEFINCH.

Specimens: 1 female (o.n.e.), Wangasara, 8 March 1985; 2 males (t.n.e.), Lankapakalu, 17 March 1985.

Measurements: (male) wing 84.5, 90, culmen 12.8, 14, tail 52.5, 57.2, weight 17.5, 19.5; (female) wing 83.5, culmen 12.1, tail 55.5, weight 22.

Soft parts: (male) iris and legs dark brown, bill dark brown, grey basally; (female) iris brown, legs dark brown, maxilla brownish horn, mandible pale brownish horn.

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APPENDIX

Our accounts treated only birds recorded by our survey parties. The following list includes those species not recorded by us but noted in the region by either the Vernay group, Abdulali, or Price. Together with our species accounts, this represents a total of 216 species recorded, to date, from the Visakhapatnam Ghats (which we have delineated to include the entire contiguous uplifted region north of the Godavari and south of the Mahanadi).

Little Egret *Egretta garzetta*. Price: Thajangi Reservoir.

Pond Heron *Ardeola grayii*. Vernay: Anantagiri; Price: Lammasinghi.

Whitenecked Stork *Ciconia episcopus*. Abdulali: Koraput, Jeypore.

Blacknecked Stork *Ephippiorhynchus asiaticus*. Price: Lammasinghi.

White-eyed Buzzard-Eagle *Butastur teesa*. Abdulali: Lammasinghi.

Changeable Hawk-Eagle *Spizaetus cirrhatus*. Abdulali: near Araku.

Indian Whitebacked Vulture *Gyps bengalensis*. Abdulali: Lammasinghi.

Black Vulture *Sarcogyps calvus*. Vernay: Sankrametta.

Pied Harrier *Circus melanoleucos*. Vernay: Jeypore.

Pale Harrier *Circus macrourus*. Vernay: Jeypore.

Painted Partridge *Francolinus pictus*. Abdulali: Chintapalli.

Painted Bush Quail *Perdicula erythrorhyncha*. Price: Lammasinghi.

Common Bustard-Quail *Turnix suscitator*. Price: Lammasinghi.

Redwattled Lapwing *Vanellus indicus*. Abdulali, Price: Lammasinghi.

Woodcock *Scolopax rusticolus*. Abdulali: Solabum, Paderu.

Fantail Snipe *Gallinago gallinago*. Abdulali: near Koraput.

Wood Sandpiper *Tringa glareola*. Price: Thajangi Reservoir.

Painted Snipe *Rostratula benghalensis*: Price: Thajangi Reservoir.

Indian Cuckoo *Cuculus micropterus*. Abdulali: Anantagiri, Lammasinghi; Price: Lammasinghi.

Small Cuckoo *Cuculus poliocephalus*. Price: Lammasinghi.

Rufousbellied Plaintive Cuckoo *Cuculus merulinus*. Abdulali: Anantagiri, Lammasinghi; Price: Lammasinghi.

The Cuckoo *Cuculus canorus*. Vernay: Sankrametta.

Whitebreasted Kingfisher *Halcyon smyrnensis*. Price: Lammasinghi.

Chestnutheaded Bee-eater *Merops leschenaultii*. Price: Lammasinghi.

Green Bee-eater *Merops orientalis*. Abdulali: Chintapalli, Price: Lammasinghi.

Wryneck *Jynx torquilla*. Abdulali: Chintapalli; Price: Lammasinghi.

Swallow *Hirundo rustica*. Price: Thajangi Reservoir.

Wiretailed Swallow *Hirundo smithii*. Price: Thajangi Reservoir.

Baybacked Shrike *Lanius vittatus*. Vernay: Sankrametta; Abdulali: Sankrametta, Lammasinghi; Price: Lammasinghi.

Black Drongo *Dicrurus adsimilis*. Abdulali and Price: Lammasinghi.

Brahminy Myna *Sturnus pagodarum*. Abdulali: Lammasinghi, Anantagiri; Price: Lammasinghi.

Pied Myna *Sturnus contra*. Price: Lammasinghi.

Indian Tree Pie *Dendrocitta vagabunda*. Vernay: Anantagiri, Sankrametta; Abdulali: Lammasinghi.

Jerdon's Leaf Bird *Chloropsis cochinchinensis*. Vernay: Jeypore; Abdulali: Anantagiri.

Brook's Flycatcher *Muscicapa poliogenys*. Vernay: Anantagiri, Sankrametta.

Grasshopper Warbler *Locustella naevia*. Price: Lammasinghi.

Lesser Whitethroat *Sylvia curruca*. Vernay: Anantagiri.

Streaked Fantail Warbler *Cicticola juncidis*. Price: Chintapalli.

Thickbilled Warbler *Acrocephalus aedon*. Vernay: Jeypore; Price: Lammasinghi.

Palefooted Bush Warbler *Cettia pallidipes*. Vernay: Sankrametta.

Plain Leaf Warbler *Phylloscopus inornatus*. Vernay: Sankrametta, Anantagiri, Price: Lammasinghi.

Largebilled Leaf Warbler *Phylloscopus magnirostris*. Price: Lammasinghi.

Tickell's Leaf Warbler *Phylloscopus affinis*. Vernay: Anantagiri; Price: Lammasinghi.

Bluethroat *Erithacus svecicus*. Price: Lammasinghi.

Stone Chat *Saxicola torquata*. Price: Lammasinghi.

Indian Robin *Saxicoloides fulicata*. Vernay: Sankrametta; Abdulali and Price: Lammasinghi.

Blue Rock Thrush *Monticola solitarius*. Price: Lammasighi.

Tickell's Thrush *Turdus unicolor*. Vernay: Anantagiri; Price: Lammasinghi.

Tree Pipit *Anthus trivialis*. Vernay: Anantagiri, Sankrametta; Abdulali: Chintapalli.

Paddyfield Pipit *Anthus novaeseelandiae*. Vernay: Jeypore; Abdulali: Lammasinghi; Price: Chintapalli.

Pied Wagtail *Motacilla alba*. Abdulali: near Koraput; Price: Thajangi Reservoir.

Large Pied Wagtail *Motacilla maderaspatensis*. Abdulali: near Koraput; Price: Thajangi Reservoir.

Baya *Ploceus philippinus*. Abdulali: Chintapalli; Price: Lammasinghi.

TENDENCIES IN NORTH-SOUTH PREFERENCES IN THE ORIENTATION OF SILKWORM[1]

M. V. V. Subrahmanyam and P. M. Chandrasekhar[2]

The larvae of *Bombyx mori* in a four way choice box execute their magnetic compass heading to spin cocoons and their proportion of movement from east-west axis is equal to either direction of south-north. Additional magnetic field elicited a behaviour in which the larvae totally lost the sense of direction. However, the magnetic influences were not observed on the quantity of silk spun.

Introduction

Animals rely on many sensory cues to orient their movements (Carthy 1951, Edrich 1977, MacGregor 1948, Van Frisch 1950). The magnetic field perception was first observed in birds (Griffin 1944) and it exists in lower organisms also (Brown 1962, Palmer 1963). *Drosophila* prefer to fly within a magnetic field (Wehner and Labhart 1970) and the bees construct their hives depending on geomagnetism (Jong 1980, Martin and Lindauer 1973). Geomagnetism is also pronounced in higher vertebrates and used commonly in homing behaviour (Keeton 1971, Philips and Alder 1978, Yeagley 1947, 1951). Recent studies emphasize the possibility of magnetic materials in animals (Presti and Pettigrew 1980), and the view on "personal magnetism" was expressed from bacteria to man (Maugh 1982).

The present study was designed to investigate geomagnetic influences on the orientation of silkworm in cocoon formation and also the influence of additional magnetic field (AMF) on the orientation of a spinning larva.

Material and Methods

Larvae of silkworm *Bombyx mori* NB_{18} reared in the laboratory were maintained on mulberry leaves. Healthy fifth instar larvae attaining spinning stages were selected for experimentation. Wooden boxes with four arms, each arm measuring 7.6 × 3.8 × 10 cm. were placed with arms facing south, north, east and west directions. The arms were orientated on a flat working table to a desired direction using a compass. One spinning larva was introduced into the centre of the four way choice box.

The box was covered with a transparent cellophane paper to prevent crawling of worms out of the walls of the arms. The box was placed under diffused light for spinning in an undisturbed area.

Induction of magnetic field: Two circular (Helmholtz) coils with 28 cm diameter and a winding length of 80 cm, were used for experiments and the distance between the two coils was 10 cm. Each coil consisted of 1500 turns, which were wound uniformly on an aluminium frame. At a 12 input DC voltage, the current in each Helmholtz coil measured 0.5A, resulting in creating an additional magnetic field 11.8 H. The dissipated power caused no significant rise in temperature to injure the spinning larvae.

Statistical analysis: A Chi-square test was employed to relate the proportion of cocoons spun in the arms facing different directions. Analysis of variance for the differences in

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cocoon weights and correlation regressions were fitted for the relation between weight-length, length-width and width-weight. Statistical analysis was carried out using DCM microsystem 1211.

RESULTS

When a healthy and fully matured fifth instar larva is inserted at the centre of the four-way choice box, the larva wanders and finally migrates to one of the arms and settles there for spinning. Under normal geomagnetic conditions, the direction of migration and orientation seems to be polarized (Table 1). A significant majority of the larvae chose to move to the arms facing north-south axis. When the natural geomagnetic field is cancelled or nullified by the application of electromagnetic field, the north-south axial migration of the larvae is disturbed and the larvae settle haphazardly in the four arms of the choice box (Table 1).

TABLE 1

DIRECTIONAL PREFERENCE BY THE SILKWORM LARVA INSERTED IN A FOUR-WAY CHOICE BOX

Larval orientation with respect to	X^2 value	Condition of the electro-magnet
South (90), North (86) East (52) and West (56)	16.507*	Off
South-east (29) and South-west (26)	0.666	Off
North-east (27) and North-west (19	4.333	Off
South (49), North (50) East (48) and West (49)	0.650	On
South-east (23) and South-west (24)	0.166	On
North-east (27) and North-west (25)	0.133	On

* highly significant.

Figures in parentheses refer to number of larvae settled in each arm.

When the box is rotated so that the arms face the intermediate directions like south east-south west and north east-north west axis and the larvae are inserted at the centre of the box, the migration and orientation of the larvae becomes jumbled up, and no significant change in their orientation for spinning resulted (Table 1). The electromagnetic field has not altered this behaviour.

Concentration of the larvae in south-north axis of the choice box could be a result of some sort of taxis. The worms prior to cocoon spinning exhibit a characteristic exploratory behaviour in the four-way choice box before they actually settle down for spinning. The navigation of an individual larva in the centre of the choice box to north-south axis is interesting. The larva makes a search, raises its head and rotates itself until it finds the north-south direction. If the larva is left at the mouth of north or south arm, it slowly moves on to find a congenial place in the arm for spinning. If it is left near the mouth of west or east arm, it shows exploratory behaviour and spends a long time crawling. Most of such larvae find the north or south arms when they crawl to the centre of the box. While the behaviour being so in confined larvae, the majority of the unconfined larvae orient their cocoons with the long axis parallel to the north-south axis.

Qualitative parameters like weight, width and length of cocoons showed some degree of dependency on the directional preference (Tables 2 and 3). Weight and width characteristics of cocoons in north arm yielded greater correlation coefficients (r) (Table 3) and the fact obviously shows that the cocoons spun in the arm pointing north-south axis are of good quality.

DISCUSSION

Living organisms are sensitive to fluctuations in geomagnetic fields (Brown 1959, Brown *et* *al.* 1960a, Brown 1962, Keeton *et al.* 1974). The present findings of silkworm movements in a choice chamber indicate that the larvae exhibit geomagnetic orientation during spinning, and the results are similar to those observed in snails and birds (Brown *et al.* 1960b, Visalberghi and Alleva 1979). *Bombyx mori* larvae placed at the centre of the four-way choice box prefer north-south arms to spin their cocoons. This orientation is a result of an exploratory behaviour of the confined larvae. Raising its head, the confined larva rotates itself to find its way into north-south axis. The unconfined larvae orient their cocoons to lie with their long axis parallel to north-south axis.

TABLE 2

LENGTH, WIDTH AND WEIGHT OF COCOONS SPUN IN THE ARMS OF THE FOUR-WAY CHOICE BOX

Arm	Weight* g	Length* cm	Width* cm
South	208.78±28.36	3.3 ±0.18	1.79±0.24
North	196.72±18.51	3.28±0.17	1.77±0.12
East	193.11±14.49	3.26±0.15	1.79±0.13
West	200.39±17.77	3.41±0.17	1.83±0.16

* mean ± SD of 18 observations.

TABLE 3

CORRELATION REGRESSION BETWEEN WEIGHT, WIDTH AND LENGTH OF COCOONS SPUN IN THE ARMS OF THE FOUR-WAY CHOICE BOX (BASED ON THE RAW DATA OF TABLE 2)

Direction	r values Weight/ Length	Weight/ Width	Length/ Width
South	0.284	0.658*	0.374
North	0.511*	0.690*	0.336
East	0.427	0.647*	0.070
West	0.638*	0.585*	0.508*

* Significant at 5%.

The mechanisms by which the larvae end up in the north-south arms of the choice box must be sought in the occurrence of sensory cues delivered by special sense organs situated in the head region. It is usually the dip vector of the earth's field that animals use and probably in the present instance also, the larvae use the same vector to make their choice when they are inserted at the centre of the box. The dip at Bangalore is 13°, with horizontal component being 0.38H and vertical component of 0.088. The abolition of north-south axial migration of the larvae in the additional magnetic field (AMF) further confirms the fact that the larvae are sensitive to the earth's field. Hornet nest pattern (Kisliuk and Ishay 1978) and bee comb building (Martin and Lindauer 1977) are known to be altered by induced magnetic field. North-south seeking magnetotactic response observed in the silkworm could be an orthokinesis. For all such magnetotactic responses the magnetosomes situated in the head region of the larvae might be responsible (Maugh 1982). Although the silkworm is totally domesticated now, it is interesting to note the persistence of orthokinetic responses not influenced by domestication.

The impact of geomagnetic responses in the larvae not only orient the worm to start spinning but also influence the quality of cocoon, adjudged by the cocoons spun by worms oriented north-south axis of the choice box.

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CLADOCERA OF DHARWAD (KARNATAKA STATE)[1]

C. S. Patil and B. Y. Gouder[2]

(*With seven plates*)

A total of 22 species of freshwater Cladocera from Dharwad area, Karnataka State have been identified and described. Of these, 17 species are hitherto not recorded from South India and a species, *Guernella raphaelis* Richard is new to the Indian subcontinent. The distribution of individual species in the water bodies and their total percentage occurrence have also been studied.

Introduction

This paper reports the results of an extensive survey of cladocerans from Dharwad (Karnataka State) in which 22 species belonging to 17 genera and six families have been recorded. Of these, 17 species are new to South India and 1 species is new to the Indian subcontinent. (Table 1).

Material and Methods

The collections of zooplankton were made fortnightly for one year (January to December, 1979) by using plankton hand net made of nylon bolting cloth (mesh size 50 μm). Cladocera adhering to weeds were collected by rinsing the weeds vigorously in a bucket and sieving through bolting nylon. The material was fixed and preserved in 4% formalin, individual species were sorted, their whole mounts stained with borax carmine and mounted in glycerine jelly. Parts of taxonomic importance were dissected and processed in a similar manner. Camera lucida drawings were made from the mounts of the entire body or their parts. Identification up to species was based on the key/description given by Brooks (1959), Biswas (1971), Nayar (1971), Fernando (1974) and Smirnov (1974, 1976).

Study area

Dharwad has a hilly terrain 784 m above MSL. The maximum atmospheric temperature is 36°C in April-May and the minimum is 14°C during December-January. The average rainfall is 53 mm and the relative humidity ranges from 43 to 80%.

The 26 water bodies surveyed included one reservoir, 19 irrigation tanks, three ponds and three temporary pools. The reservoir has been recently constructed and is used for irrigation. Its water is clear and has marginal aquatic vegetation. Of the 19 tanks, three were without aquatic vegetation and their water was clear. Seven other tanks abound in rooted and floating vegetation. The remaining nine tanks show muddy brown water. The pond water was muddy and showed scanty phytoplankton. The temporary pools were highly turbid.

Taxonomic account

Family: Sididae

Diaphanosoma excisum Sars, 1885 (Pl. I, Figs. 1-3)

Distinguished by its large head with relatively small eyes, body brown to yellow. Num-

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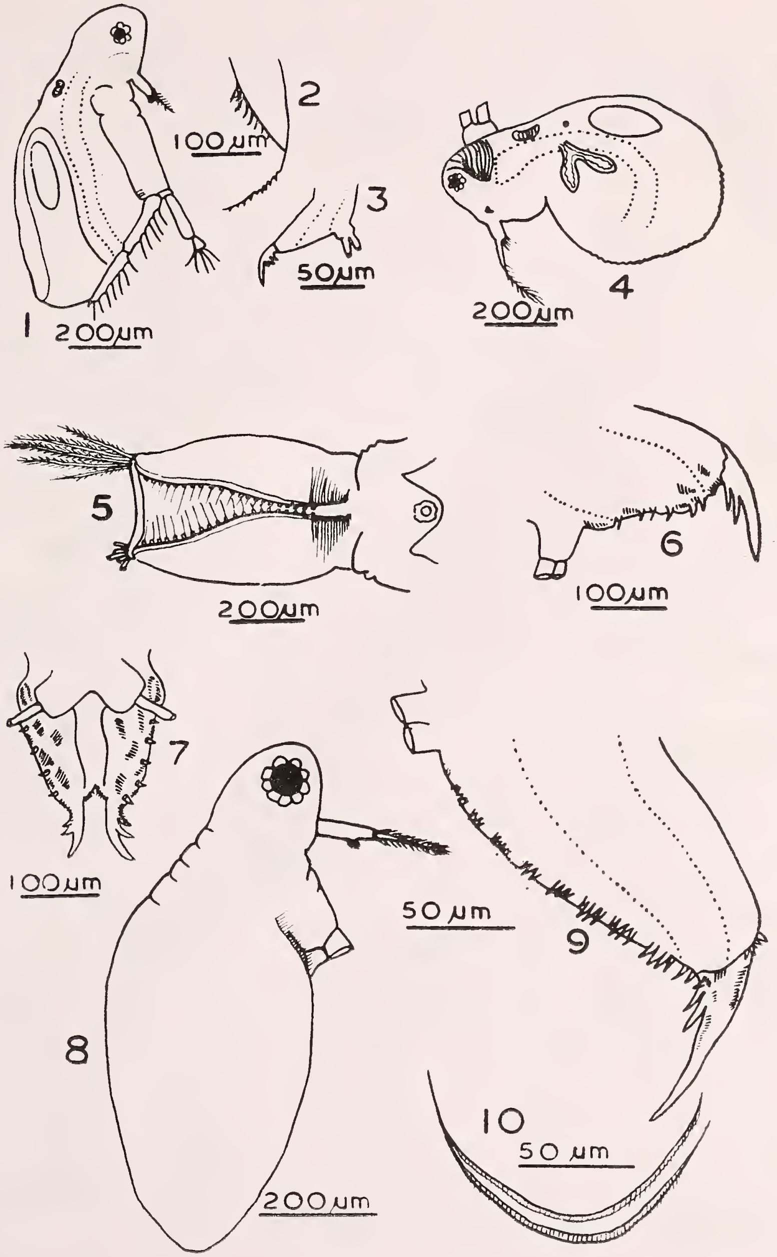
[1] Accepted May 1982.

[2] Department of Zoology, Karnatak University, Dharwad-580 003.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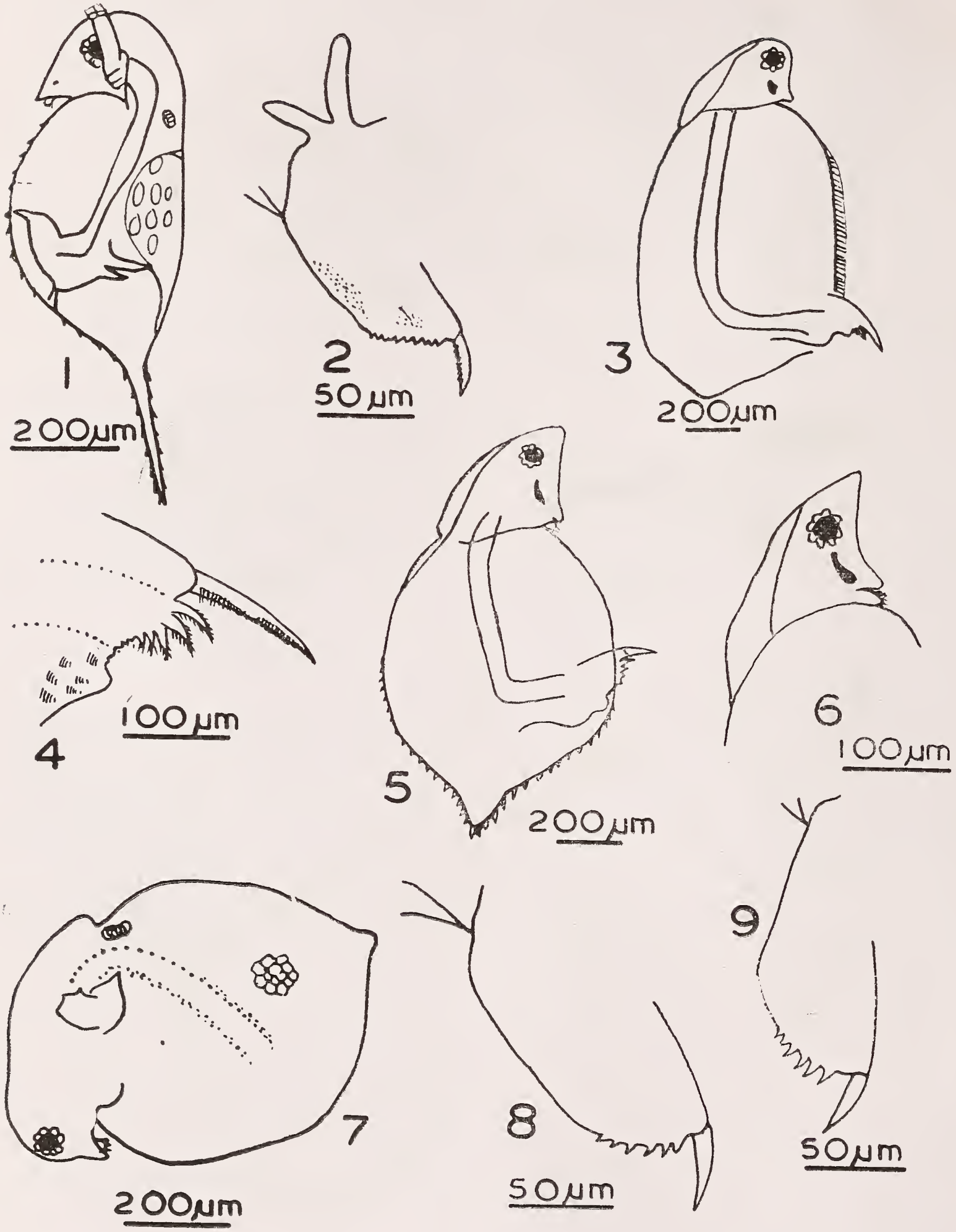
1. *Diaphanosoma excisum* Sara, lateral view; 2. Postero-ventral part of the shell; 3. Postabdomen; 4. *Latonopsis australis* Sars; 5. *L. australis,* ventral view; 6. Postabdomen, lateral view; 7. Postabdomen, dorsal view; 8. *Pseudosida bidentata* Herrick; 9. Postabdomen; 10. Posterior part of the shell.

Patil & Gouder: Cladocera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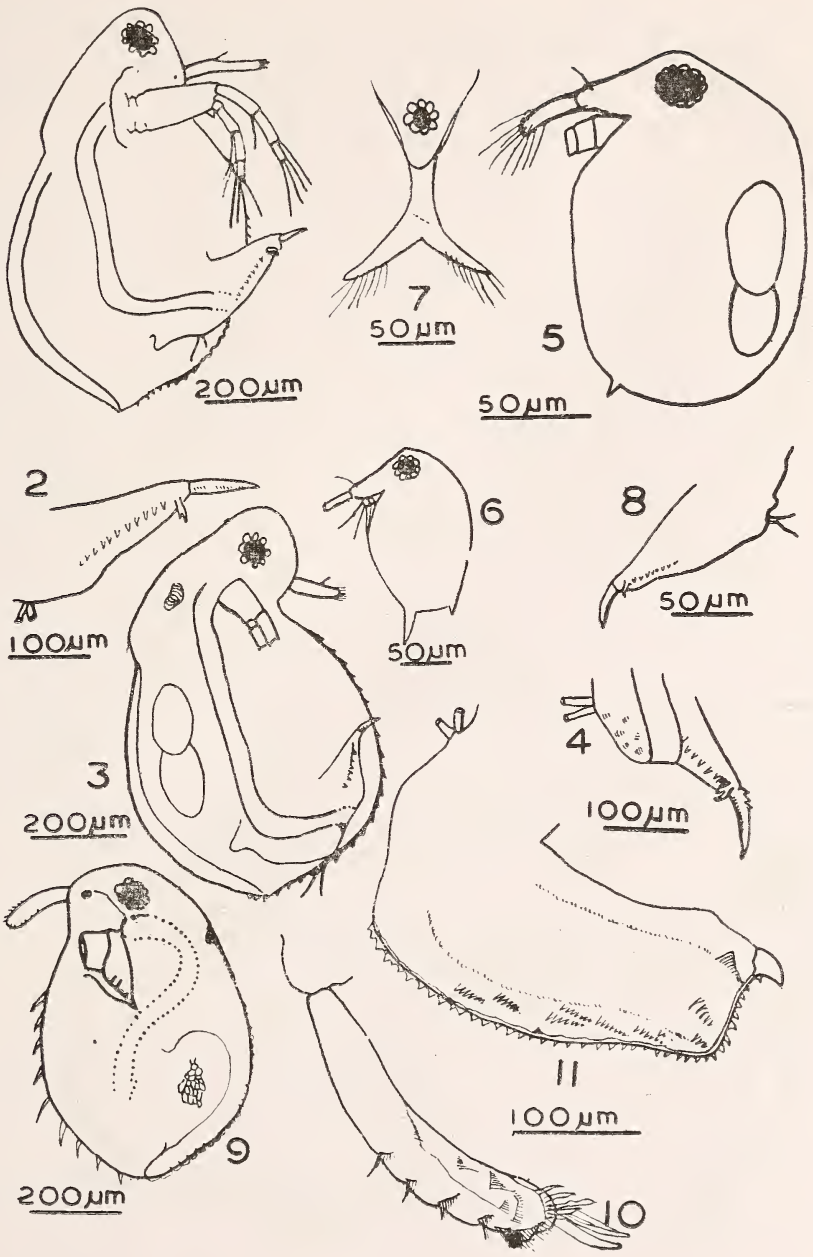
1. *Daphnia carinata* King; 2. Postabdomen; 3. *Simocephalus exspinosus* Koch; 4. Postabdomen, enlarged; 5. *S. elisabathe* King; 6. Head region enlarged; 7. *Ceriodaphnia cornuta* Sars; 8. Postabdomen; 9. *C. laticaudata* Muller, Postabdomen.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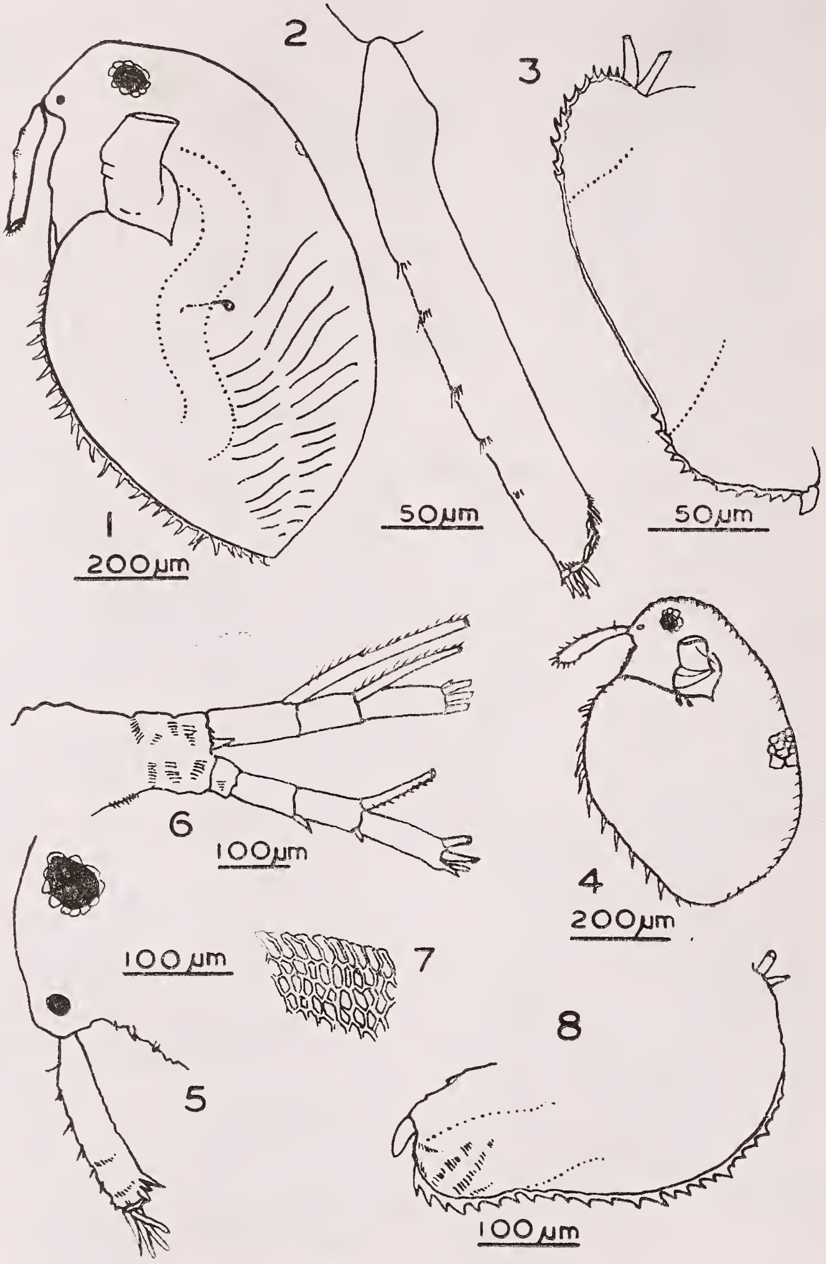
1. *Moina micrura dubia* Kurz; 2. Postabdomen; 3. *Moinodaphnia macleayi* King; 4. Postabdomen; 5 & 6. *Bosminopsis dietersi* Richard; 7. Antennules, ventral; 8. Postabdomen; 9. *Macrothrix laticornis* Fischer; 10. Antennule; 11. Postabdomen.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1. *Echinisca odiosa* Gurney; 2. Antennule; 3. Postabdomen; 4. *Machothrix geoldi* Richard; 5. Head region enlarged; 6. Antenna; 7. Part of the shell, dorsal; 8. Postabdomen.

TABLE 1

CLADOCERAN SPECIES COMPOSITION AND PERCENT DISTRIBUTION IN FRESHWATER BODIES OF DHARWAD

Cladoceran species	Reservoir (1)	Tanks with clear water (3)	Tanks with aquatic vegetation (7)	Tanks with brown & muddy water (9)	Ponds (3)	Temporary Pools (3)	Total No. of water bodies showing species	% distribution of species
1. *D. excisum*	1	1	5	7	2	1	17	77.3
2. **L. australis*	–	–	2	–	–	–	2	9.0
3. **P. bidentata*	–	–	2	–	–	–	2	9.0
4. *D. carinata*	–	–	–	1	2	2	5	22.7
5. *C. cornuta*	–	1	3	5	2	1	12	54.5
6. **C. laticaudata*	1	–	1	–	2	–	4	18.0
7. **S. exspinosus*	–	–	2	–	–	–	2	9.0
8. **S. elisabathe*	–	–	2	–	–	–	2	9.0
9. **M. micrura dubia*	–	–	1	–	1	–	2	9.0
10. **M. macleayi*	–	–	1	–	–	–	1	4.5
11. **B. dietersi*	1	–	–	–	–	–	1	4.5
12. *M. laticornis*	–	–	3	–	–	–	3	13.6
13. **M. geoldi*	–	–	2	–	–	–	2	9.0
14. **E. triserialis*	–	–	3	–	–	–	3	13.6
15. **E. odiosa*	–	–	2	–	–	–	2	9.0
16. ***G. raphaelis*	–	–	1	–	–	–	1	4.5
17. **I. spinifer*	–	–	2	–	–	–	2	9.0
18. **B. karua*	–	–	2	–	–	–	2	9.0
19. **P. trigonellus*	–	–	2	–	–	–	2	9.0
20. **C. reticulatus*	1	1	3	1	1	–	7	29.7
21. **C. faviformis*	–	–	1	–	–	–	1	4.5
22. **D. serrata*	–	–	3	–	–	–	3	13.6

* New records to South Indian region.
** New record to Indian subcontinent.

ber of teeth on the postero-ventral shell margin highly variable; sometimes the teeth look like incisions.

Recorded earlier from India by Biswas (1971). Nayar (1971) from Rajasthan, by Michael (1973) from Tamil Nadu and Sharma (1978) from Bengal.

Distribution: Common in tropics and subtropics.

Latonopsis australis Sars (Pl. I, Figs. 4-7)

Body large and slightly elliptical with a thin shell. Head small with relatively large eyes. Terminal part of the antennule with a long flagellum and a set of setae. Ventral and posterior margins of the shell valves serrated, with long, unequal setae beset with fine bristles. Three long setae on the posterior margin of the valve. Postabdomen broad, anal spines vary from 5-7.

Reported earlier by Biswas (1971) from Rajasthan.

Distribution: Australia, Sri Lanka, India.

Pseudosida bidentata Herrick, 1884 (Pl. I, Figs. 8-10)

Body similar to that of *Sida* but head more depressed. Rostrum present; fornix absent. Postabdomen with 8-14 clusters of spinules with large basal spines.

Recorded from Northeast India (Michael & Sharma, personal communication).

Distribution: South Africa, Sri Lanka, India.

Family: DAPHNIDAE

Daphnia carinata King, 1853 (Pl. II, Figs. 1, 2)

Body brown and transparent. Head crested with a minute antennule. Postabdomen broad with 10-12 anal spines. Numerous dots present on the lateral side of the postabdomen.

Recorded earlier by Biswas (1964) from Simla hills, Biswas (1971) from Rajasthan, Michael (1973) from Tamil Nadu and Sharma (1978) from Bengal.

Distribution: Tropics.

Simocephalus exspinosus (Koch, 1841) (Pl. II, Figs. 3, 4)

Head small with round vortex. Posterior part of body blunt. Ocellus rhomboidal in shape. Postabdomen slightly narrow towards apex with slightly curved spines. Claw long with pecten at its base and with a row of teeth distal to the pecten.

Recorded from Northeast India (Patil 1976), Bengal (Sharma 1978).

Distribution: Cosmopolitan.

S. elisabathe (King, 1853) (Pl. II, Figs. 5, 6)

Similar to *S. acutirostris* Sars with crested vortex, but differs in having a spiny protuberance at the posterior margin of the shell. The shape of the posterior margin of the shell is important in judging the validity of this taxon and the protuberance is characteristic of *elisabathe*.

Recorded by Biswas (1971) from Rajasthan, India.

Distribution: Europe, tropics and subtropics.

Ceriodaphnia cornuta Sars, 1885 (Pl. II, Figs. 7, 8)

Horn on head absent but a horn-like process seen in front of the antennules.

Reported earlier from Lahore (Arora 1931), Karnataka (Gouder & Joseph 1961), Rajasthan (Biswas 1971, Nayar 1971), Tamil Nadu (Michael 1973), Northeast India (Patil 1976).

Distribution: South America, Africa, Sri Lanka and India.

C. laticaudata Muller, 1867 (Pl. II, Fig. 9)

Body oval with rounded vortex. Postabdomen large, dilated near the middle and obliquely truncated.

Reported from Simla hills (Biswas 1964), Rajasthan (Biswas 1971), Bengal (Sharma 1978) and from Jammu (Chowdhary *et al.* 1978).

Distribution: India, U.S.A., Sri Lanka.

Family: MOINIDAE

Moina micrura dubia Kurz (Pl. III, Figs. 3, 4)

Head large, with rounded vortex and a deep cervical sinus. Supraocular depression absent Postabdomen with 8-10 postanal spines with terminal long bident. The claw bears minute denticles.

Recorded from Rajasthan (Biswas 1971), Bengal (Sharma 1978).

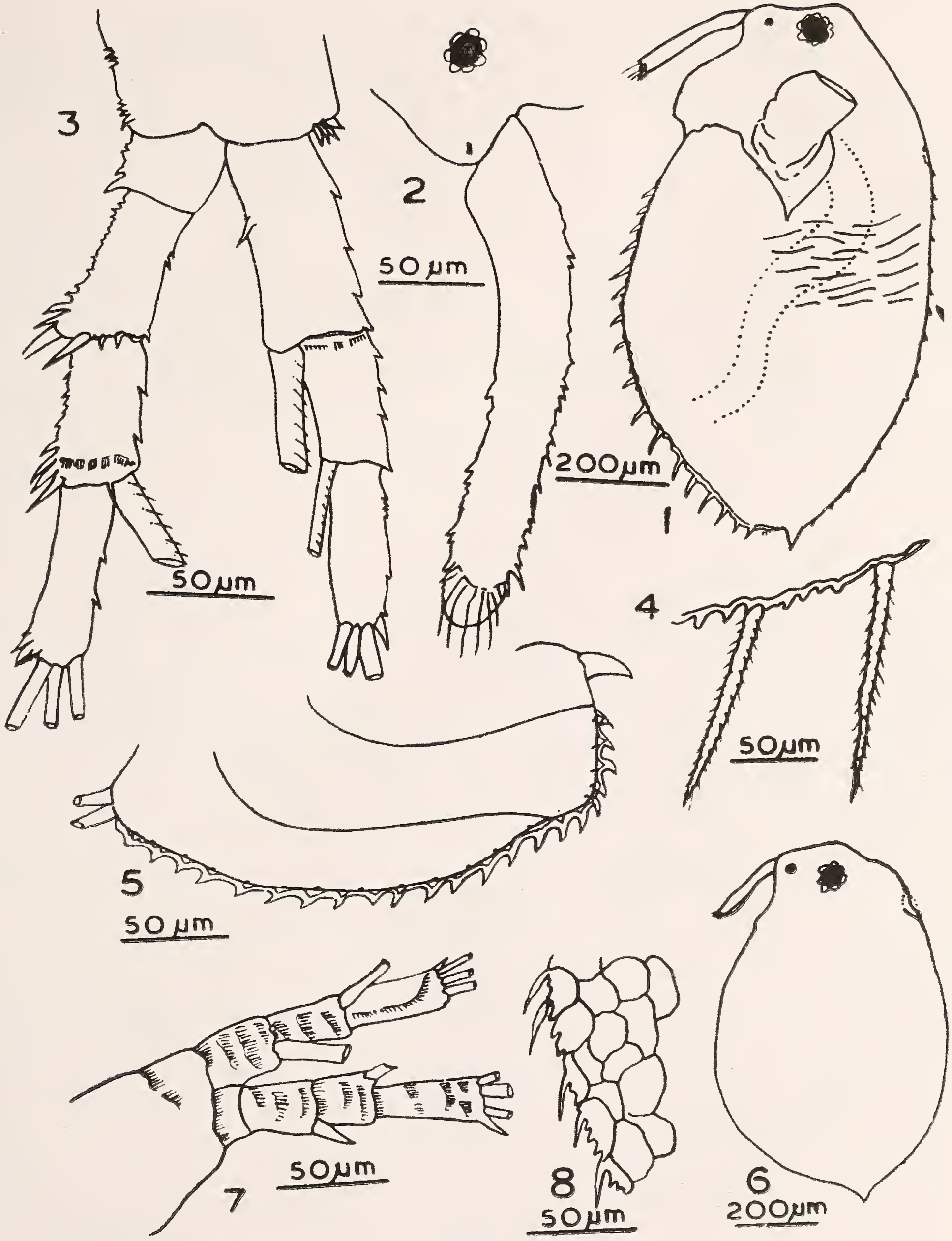
Distribution: India, Sri Lanka, Africa.

Moinodaphnia macleayi King, 1853 (Pl. III, Figs. 1, 2)

Characterized by tumid valves at the posterodorsal part. Sensory seta on the antennule is towards the base. Postabdominal claw denticulate.

Sharma (1978) recorded it from Bengal.

Distribution: India, Sri Lanka.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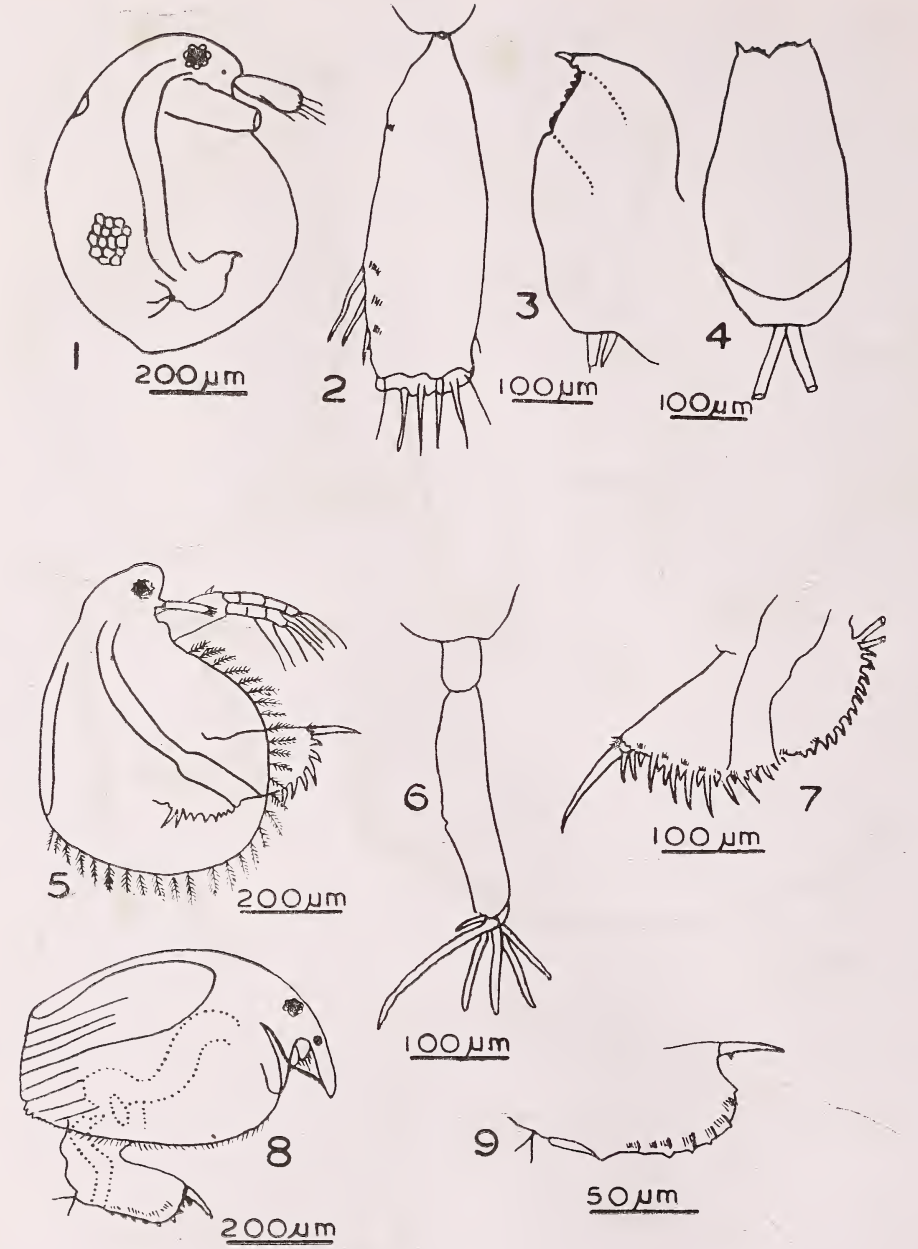
1 & 6. *Echinisca triserialis* Brady; 2. Antennule; 3 & 7. Antenna; 4 & 8. Ventral margin of the shell, enlarged; 5. Postabdomen.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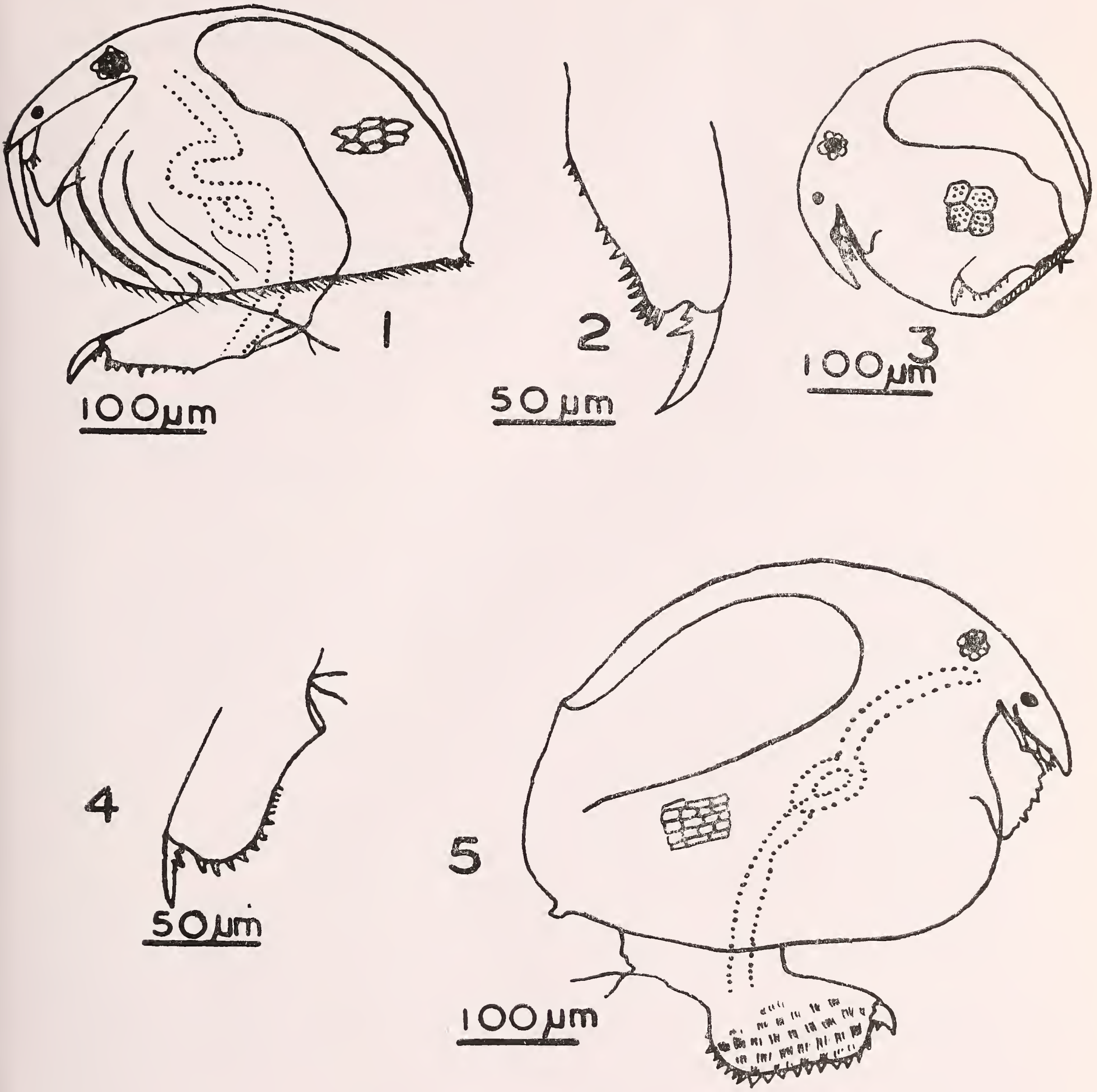
1. *Guernella raphaelis* Richard; 2. Antennule; 3. Postabdomen; 4. Postabdomen dorsal; 5. *Ilyocryptus spinifer* Herrick; 6. Antennule; 7. Postabdomen; 8. *Biapetura karua* King; 9. Postabdomen.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1. *Pleuroxus trigonellus* Muller; 2. Postabdomen; 3. *Chydorus reticulatus* (Jurine); 4. Postabdomen; 5. *Dunhevidia serrata* Daday.

Family: BOSMINIDAE

Bosminopsis dietersi Richard, 1895 (Pl. III, Figs. 5-8)

Small, oval and transparent. Antennules united at the base and diverted at apex. Two spines on postero-dorsal and postero-ventral part of shell in one form (Fig. 6). In another form there is a single, small spine on postero-ventral region (Fig. 5). Postabdomen tapers.

Recorded from Northeast India (Michael & Sharma, personal communication).

Distribution: South and Central America, Sri Lanka, India.

Family: MACROTHRICIDAE

Macrothrix laticornis Fischer, 1851 (Pl. III, Figs. 9-11)

Body rounded. Postcervical part of the dorsal edge finely serrated. Antennule long, distally broader with setiferous projections towards posterior end. Anterior margin of antennule with several fine incisions and a cluster of hairs. Postabdomen bears numerous fine spines with a small claw. Tufts of fine hairs along flanks of postabdomen.

Recorded earlier from Pakistan by Arora (1931) from Lahore, Chowdhary *et al.* (1978) from Jammu.

Distribution: Cosmopolitan.

M. geoldi Richard, 1897 (Pl. IV, Figs. 4-8)

Dorsal margin of shell deeply serrated. Hexagonal markings compactly arranged on surface of valves. Antennules bulge towards apex and have 4-6 unequal setae and a small spine on the postero-ventral region. Small spines extend from the base of the antennule towards the antero-ventral part of the shell margin.

Recorded from India by Nayar (1971) from Rajasthan, Sharma (1978) from West Bengal.

Distribution: Africa, Sri Lanka, India, U.S.S.R.

Echinisca triserialis Brady, 1886 (Pl. V, Fig. 1-8)

Highly variable but easily recognised by its zig-zag, serrated margin on the ventral part of the shell. Shell valves covered with loosely arranged cells of irregular shape. A small pointed spine-like projection on posterior part of shell. In one form, there are clusters of spines on the basal segment of the antenna (Fig. 3), whereas in another form, groups of hair-like bristles are noticed on each ramus in the antenna and their joints (Fig. 7). Though there is a marked difference in the presence of spines and hair-like bristles on the antenna, both are considered as *E. triserialis* Brady, since the structure of the ventral margin of the shell is similar which is the characteristic of this taxon. Post-abdomen large, with numerous saw-like backwardly curved spines.

Recorded from India by Sharma (1978) from West Bengal.

Distribution: U.S.S.R., India, Africa, Sri Lanka, South America.

E. odiosa Gurney, 1907 (Pl. IV, Figs. 1-3)

Similar to *E. triserialis* Brady. Antennule attached on a pointed, triangular rostrum. Shell valve with rugose markings on its surface. Postabdomen slightly tapering, postabdominal spines slightly longer on pre-and post-anal part.

Reported from Northeast India (Michael & Sharma, personal communication).

Distribution: India, U.S.S.R., Africa.

Guernella raphaelis Richard, 1893 (Pl. VI, Figs. 1-4)

Body oval. Shell valves tumid with small reticulated cells. Antennule thick, uniformly broad with a slight narrowing at the base. 6-8 terminal setae and 3 lateral unequal setae on antennule. Postabdomen small with 6-8 minute anal spines. In the species described by Smirnov (1976), the postanal part of the postabdomen is more bulged with groups of hairs and there are small bristles on the dorsal surface of the antennule. The specimens observed by us are similar to those described by Fernando (1974) from Sri Lanka, without bristles on the antennule.

This species is new to India.

Distribution: Sri Lanka, Africa, India.

Ilyocryptus spinifer Herrick, 1884 (Pl. VI, Figs. 5-7)

Body flat, vortex of head forms a sharp angle in front of insertion of antennules. Antennule two-jointed. Antenna short, with very long, numerous antennary setae. Long, numerous setae with branches on postero-dorsal and ventral part of shell. Postabdomen large, with numerous long spines with denticles.

Sharma (1978) recorded it from Bengal.

Distribution: India, Australia, U.S.S.R., Indonesia, Africa, North and South America.

Family: CHYDORIDAE

Biapetura karua King, 1883 (Pl. VI, Figs. 8, 9)

Shell valve has longitudinal striations with fine polygonal markings. Postero-ventral margin of valve with 1-5 denticles. Postabdomen broad and rounded at dorsal margin, with 8 small anal denticles. Groups of lateral setae on postabdomen.

Recorded from West Bengal by Sharma (1978).

Distribution: U.S.S.R., Central Asia, Sri Lanka, India.

Pleuroxus trigonellus (Muller, 1785) (Pl. VII, Figs. 1, 2)

Body ovate with an angled posterior part. Rostrum flexed forward. In our specimens, infero-posteal margin has two minute denticles whereas Nayar (1971) noted four denticles. Dorsal margin of postabdomen convex, with rounded apex. Postabdomen with 14-16 marginal denticles which are larger towards apex.

Nayar (1971) recorded it from Rajasthan.

Distribution: India, Canada, North and South America.

Chydorus faviformis (Birge, 1893)

Distinguished by the deep, polygonal markings on the head shield and valves of the shell. The details of the taxa could not be described as only one specimen occurred in the collections.

Recorded earlier from India by Michael & Sharma (personal communication).

Distribution: Northeast Asia, India, North America.

C. reticulatus Jurine (Pl. VII, Figs. 3, 4)

Body spherical and deep yellow in colour. The valves have polygonal reticulated markings with numerous black dots in each.

Reported from Rajasthan by Biswas (1971).

Distribution: India, Africa.

Dunhevidia serrata (Daday, 1898) (Pl. VII, Fig. 5)

Characterized by a bifid labrum which has a serrated margin having 10-12 denticles. Postabdomen with numerous lateral groups of setae.

Reported from Northeast India (Michael & Sharma, personal communication).

Distribution: Africa, Sri Lanka, New Guinea, India, North America.

ACKNOWLEDGEMENTS

We thank Dr. B. K. Sharma, Northeastern Hill University, Shillong for his help in identifying some cladoceran species and for suggestions. The award of Junior Fellowship by University Grants Commission, New Delhi to one of us (CSP) is gratefully acknowledged.

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A CATALOGUE OF THE BIRDS IN THE COLLECTION OF BOMBAY NATURAL HISTORY SOCIETY — 33

HUMAYUN ABDULALI

MUSCICAPIDAE (Turdinae)

[*Continued from Vol. 84* (1): 125]

This part ending with Synopsis No. 1730 up to Register No. 22209, includes 1042 specimens of 44 species, subspecies and ELs of the Turdinae. There are 5 forms (3 species and 2 subspecies) of which we have no specimens in our collection. I have been assisted by Dr. (Mrs.) S. Unnithan and I am grateful for her assistance.

1692 **Cercomela fusca** (Blyth) (Muttra) Brown Rock Chat 2:54

17: 8 ♂♂ 9 ♀♀

2 Ambala, Punjab; 2 Delhi; 2 Cawnpore; 1 Sunda Hill, Jaswantpura, 1 Jaithari, Bhopal; 2 Jalor, Jodhpur State; 1 Gwalior; 1 Deesa, 1 Gangasagar, Palanpur; 2 Bhujia Fort, 1 Tapkeshwari, near Bhuj, Kutch; 1 Jabalpur, M.P.

Measurements on p. 128.

1693 **Saxicola macrorhyncha** (Stoliczka) (Rapur and Bhuj; Kachh, (Kutch) Stoliczka's Bush Chat 2:32

nil.

EL **Saxicola rubetra** (L.) (Sweden) Whinchat

4: 1 ♂ 3 ♀♀

2 *Niton, Isle of Wight*; 1 *Suffolk, U.K.*; 1 *Feluja, R. Euphrates, Mesopotamia.*

The second bird No. 2348 from Mesopotamia is marked as of the race *noskae* Tsch. (N. Caucasus) in the *Birds of Mesopotamia* JB 28, p. 402 but the validity of this form is doubted by Meinertzhagen (1954) in *Birds of Arabia* p. 258. No attempt is made to separate the two races here.

Measurements on p. 128.

1694 **Saxicola insignis** Gray (Nepal) Hodgson's Bush Chat 2:33

7: 4 ♂♂ 3 ♀♀

1 Ambala. Punjab; 2 Sarun, 4 Baghowni, Tirhut, Bihar.

The specimen from Ambala from the Jones collection appears to be the westernmost record.

Measurements on p. 128.

1695 **Saxicola torquata maura** (Pallas) (Karassun, Ishim River, W. Siberia) West Siberian Bush Chat 2:28

8: 5 ♂♂ 3 ♀♀

1 *Feluja, 2 Sheikh Saud, Mesopotamia*; 1 *Abadan,* 3 *Shiraz,* 1 *Katunak,* 8 *m. south of Shiraz, Iran.*

There has been much confusion regarding the identity and separation of this race and *indica* (No. 1697 below) at least in Indian limits. Blanford's FAUNA (1890) accepted *maura* and treated *indica* as a synonym, while Baker in the 2nd edition (1924) reversed the position. This has resulted in published names being applicable to either, depending on the work consulted.

In INDIAN HANDBOOK (1973) both races are accepted with Ticehurst's note in *Ibis* (1938, pp. 338-341) being quoted as a reference. Ticehurst accepted the close similarity of the two races, including an overlap in measurements of wing and extent of white at base of the tail but accepts a young male obtained at Nasik, Bombay in October as *maura.* Among the specimens received from the B.M. (N.H.) is a ♂ (the label marked "Nasiq, Bombay, young of year by skull') dated 5th October 1912 obtained by CBT, with a 68 mm. wing and a little white at the base of the tail. Similarly others from Belgaum, Deesa, Meerut have their wings under 70 mm. while specimens from Iran and Iraq have them 72 to 75 mm. The females are said to be inseparable from those of *indica*, but slightly larger 70, 73, 74.

With the evidence examined I am not inclined to accept any of the Indian skins as of *maura*.

Measurements on p. 128/129.

1696 **Saxicola torquata przewalskii** (Pleske) (Kansu) Tibetan Collared Bush Chat 2:30

10: ♂♂

4 nr. Madhopur, Jammu, Kashmir (28 Jan.-14 Feb.); 1 Ranikhet, U.P.); 1 Bhigurwada, 1 Partapur, Nepal; 1 Sarun, Bengal; 1 Haflong, N. Cachar (20 Oct.). 1 *Upper Burma.*

All have wings larger (74-77) than *indica* and *stejnegeri* and also no white at base of tail. The rufous on the underparts paling to some extent, extends to the undertail covert.

Measurements on p. 128/129.

1697 **Saxicola torquata indica** (Blyth) (Calcutta) Indian Collared Bush Chat

92: 56 ♂♂ (2 spotted juveniles) 31 ♀♀ 5 o?

1 *Bostan Terek,* 1 *Kaying Bashi, C. Turkestan*; 1 *Ornach Kalat, Baluchistan*; 6 Chitral, 2 Chitral Drosh, 1 Chitral Buin, 1 Taxila, Rawalpindi Dt., Punjab; 1 Kulotan Badrawar, Kashmir; 1 *E. Everest,* 1 *S. Tibet*; 11 Simla, 4 Keonthal State, 2 Jagadri, 7 Ambala, 1 Patiala State; 1 Yoshirmath, Garhwal; 1 Garhwal; 1 Polo Grounds, 1 Mussooree, 3 Meerut, 2 Delhi; 1 Kanpur; 1 Bharatpur; 1 Bhong, Bahawalpur, 1 Schwan, Larkana Dt., Sind; 1 Bhimal, Jodhpur State; 1 Satanwara, Gwalior State; 1 Ratlam, 1 Jabalpur, C.I.; 2 Chikalda, Berar; 3 Sonawani, Balaghat Div., C.P.; 2 Bailadila, Bastar, 1 Radhanpur, N. Gujarat, 1 Kutch, 1 Mandvi, 1 Nadiad Town Env.; 1 Dwarka, Gujarat, 1 Madhmeshwar, Nasik, 1 Ambernath, Kalyan; 4 Santa Cruz, 3 Andheri, Bombay; 1 Nagotna, 1 Kolaba; 1 Satara; 1 Koira, Bonai, 1 Keonjhar, 1 Harbhanga Baud, Orissa; 2 Temi, W. Sikkim; 1 Baghownie, Tirhut, 1 Benor, Darbhanga, Bihar; 1 Kurseong, Darjeeling Dt., 1 Raidak, Jalpaiguri, Bengal, 1 Gauhati, Assam.

All Indian specimens available appear to be *indica* with none *maura*. See remarks under 1695.

Measurements on p. 128/129.

1698 **Saxicola torquata stejnegeri** (Parrot) (Etorofu = 1 Iturup, Kuriles and Hokkaido) East Siberian Collared Bush Chat

13: 7 ♂♂ 6 ♀♀

(a) 10: 4 ♂♂ 6 ♀♀

1 Partapur, 1 Bhupendra, Nepal; 1 Dibrugarh, Assam; 2 *Maymyo, Upper Burma*; 1 *Kulthari,* 1 *Loileong*; 1 *Taunggyi S. Shan States,* 1 *Yebank, Henzada,* 1 *Youchaung, Thayetmyo, Burma.*

(b) 3 ♂♂ *Peking, China.*

stejnegeri are separated from *przewalskii* by their shorter wings and coarser bills, but the 3 males from Peking have their bills slightly shorter and yet coarser, than in those under (a) and are mentioned separately.

6 (4 ♂♂ 2 ♀♀) from Bangkok, Thailand, borrowed from B. M. (N.H.) have similar wings, the bills equal in length to those listed above but definitely wider at the base. Obviously the birds from south-east and eastern Asia need to be worked out in greater detail.

Measurements on p. 128/129.

EL **Saxicola torquata rubicola** Linne (Seine Inferieure, France)

12: 5 ♂♂ 6 ♀♀ 1 o?

1 *Abu Zehel,* 1 *Giza, Egypt*; 3 *Baghdad,* 3 *Shatt-el-Adhain,* 3 *Hawi Plain, Mesopotamia*; 1 *S. Persia.*

These are all marked *rubicola* by Ticehurst have rufous markings on the white rump mentioned in Meinertzhagen's BIRDS OF ARABIA. There is no white at the base of the tail and the underparts are more rufous than white.

Measurements on p. 128/129.

EL **Saxicola torquata armenica** Stegman (Village of Adzharan, Kurdisan)

3: 2 ♂♂ 1 ♀

1 *Siyahad, Arabia,* 1 *Feluja, Euphrates,* 1 *Nahr Omar, Tigris, Mesopotamia.*

The white rump and the large wing appear distinctive.

Measurements on p. 128/129.

EL **Saxicola torquata variegata** Gmelin (Azerbaijain)

5: 3 ♂♂ 2 ♀♀

4 *Shatt-el-Adhain, Mesopotamia,* 1 *Pir-i-Bama* 9 *m south of Shiraz, Iran* (14 Oct. 1917-5th February 1920).

Though marked *maura* by an earlier worker, they appear closer to this form, as accepted by Meinertzhagen in BIRDS OF ARABIA (p. 261).

Measurements on p. 128/129.

1699 **Saxicola leucura** (Blyth) (Upper Scinde) Whitetailed Bush Chat 2:31

13: 10 ♂♂ (1 by plumage) 2 ♀♀ 1 o?

2 Sukkur, Sind: 4 Kumaon Terai, 1 Hastinapur marshland, nr. Meerut, U.P.; 3 Benon, Darbhanga, Bihar; 1* Darjeeling, Bengal; 1 *Naunggyo,* 1 *Henzada dt., Lower Burma.* * missing.

Measurements on p. 129.

1700 **Saxicola caprata bicolor** Sykes (Dukhun)

56: 35 ♂♂ 17 ♀♀ 4 o?

2 *Mastung,* 1 *Sistan, Sidar,* 50 *m. S. of Kalat*; 1 *Manguli, Jhalawan,* 26° 45′N. 65° 21′E, *Baluchistan*; 1 Chitral; 2 Shikarpur, Jullundur, 1 Ladni, 1 Jutogh, 2 Solon, Bhagat State, 1 Jagadri, 3 Ambala, 1 Patiala, 1 Multan, Punjab, 1 Daulatpur, 2 town environs, Bahawalpur; 2 Delhi; 1 Jacobabad, Upper Sind, 1 Khahi Pithora, 1 Dadu Larkana, Sind; 1 Hamawas Lake, Pali, 4 Jalar, Jodhpur; 1 Jaithari, 1 Mathor, Bhopal; 2 Bhadreshwar, 1 Kharirohar, 1 Mandvi, 1 Bhuj, 1 Kutch, 1 Amreli, 1 Nadiad, 1 Mehmedabad, Kaira, 1 Cambay City, 1 Golana, Cambay; 1 Dabka, Baroda; 1 Dindori, Nasik; 1 Sonawani, Balghat M.P.; 1 Orissa, 1 Puranpur, Pilibhit, U.P.; 1 Baghowni, Darbhanga, Bihar; 1 Cawnpur, 1 Pura, 1 Almora, 1 Majkholi, Ranikhet, 1 Mussoorie, U.P.; 1 Halflong, N. Cachar.

Hartert's *rossorum* 1910, *Journ. Ornith., 58, p. 180.* type locality Merv, Southern Transcaspia is not accepted in Indian literature. As however the first four listed above were marked *rossorum* by an earlier worker, additional specimens said to be of this race, were borrowed from the British Museum and it would appear that none have the larger wing size of 76-79 (77.5) mentioned by Vaurie, and can all be included in the wide range in *bicolor,* 67-76 (70.5) among the rest. The other character of a straight line separating the black and white on the underparts is to some extent due to the nature of preparation of the skin, exaggerated by the fact that the B.M. (N.H.) specimens collected in 1901-1937 show a deeper black than our specimens dating as near as 1945. For these reasons all are now listed under *bicolor* though it is possible that more material, preferably representing breeding or ringed birds may justify this separation.

Measurements on p. 129.

1701 **Saxicola caprata burmanica** Baker (Pegu) Burmese Pied Bush Chat 2:24

36: 22 ♂♂ 12 ♀♀ 2 o?

1 Salher, Navsari Prant, Baroda; 4 Chikalda, Birar, 5 Khandala, W. Ghats; 1 Bhimashankar, W. Ghats, Pune; 1 Veral, Ratnagiri; 2 Karwar; 2 Gotigoli, 1 Honawar, N. Canara; 1 Mercara, Coorg; 2 Shenemenalla, 1 Magoolibetta, Biligirirangan Hills, 1 Sagar, Sorab Rd., Mysore; 1 Koduru, S. Cudappa, 1 Kurumbapathi, Salem Dt., 1 Lamasinghi, 1 Chinlapoth, Vizag Dt.; 1 Barkul, Chilka Lk., Orissa; 1 Rajaputtu, Saran, 2 Baghownie, Tirhut, Bihar; 2 *S. Shan States,* 1 *Tonba, Prome Dt.,* 1 *Tawngup, Sandoway,* 1 *Myoguin, Henzada Dt.* 1 *Burma.*

Measurements on p. 129.

1702 **Saxicola caprata nilgiriensis** (Whistler) (Ootacamund) Nilgiri Pied Bush Chat 2:25

13: 10 ♂♂ (2 imm.) 3 ♀♀

1 Avalanche, 1 Upper Bhavani, 1 Naduvathom, 1 Ketti, Nilgiris; 3 Kodaikanal, Palnis; 1 Munnar, 1 Devikulam, 1 Peerumedu, 3 Travancore.

The 3 females show differences in the depth of rufous on the rump. No specimens from Ceylon are available but Whistler (1940) when describing *nilgiriensis* Bull. B.O.C. 60:90 has gone into some detail to establish the necessity of accepting this form.

Measurements on p. 129.

1703 **Saxicola caprata atrata** (Kelaart) (Newera Elia, Ceylon)

nil.

1704 **Saxicola jerdoni** (Blyth) (Purneah) Jerdon's Bush Chat 2:35

3 ♂♂ (1 by plumage).

1 Rupachena, Cachar; 1 *Kindat, Upper Chindwin, Burma*; 1 no locality.

Measurements on p. 130.

1705 **Saxicola ferrea** Gray (Nepal)

79: 52 ♂♂ (8 by plumage, 4 juv.) 27 ♀♀ (5 by plumage, 3 juv.)

2 Doosoo; 1 Palaili, Bootna R., Kishtwar, Kashmir, 1 Aka Hills(?), 1 Tongme, 1 Tsong Rong, L. Tsengpo Valley, Tibet; 1 Mashobra, 1 Fagu, N.W.H.; 20 Simla; *1 Bharatpur, Rajasthan; 2 Polo grounds, 1 Mussoorie, 9 Garhwal, 1 Almora, 2 Naini Tal, 1 Sarda R., 1 Pilibhit, 1 West, 1 Kumaon, U.P.; 1 Sokipiku, Darbhanga, B.&O.; 3 Martam, Rongni Valley, Sikkim; 1 Bhutan Duars, 2 Batase, 3 Bumthang, 1 Shamgong, 2 Mangdechu, Central Bhutan; 1 Rongtong, 1 Narphong, 1 Gomchu, 1 Deothang, East Bhutan; 1 Dibrugarh, 2 Kohima, 1 Imphal, near Manipur, Assam; 1 North, 1 Cachar; 1 *N. Krang, Upper Burma*, 3 *Mt. Victoria, Pakokku Hill Tracts*, 1 *Aloikaw, South Shan States, Burma*, 1 *Thayetmyo Dist.* 1 *Ngaphaev, Prome dt.*, 1 *Sandoway*.

The specimen from Bharatpur obtained in 1970 adds to the *Checklist of Delhi, Agra & Bharatpur* wherein it was recorded from Delhi only.

The key in INDIAN HANDBOOK separates females of this species first from Jerdon's and other *Saxicola* spp. by the white throat and rufous edges to the tail. The first character is not very different in the single specimen of *S. jerdoni* and identical in the second character. Juveniles Nos. 2447 and 2448 collected at Simla on 1/6/25 by S. Basil Edwardes are marked ♂ and ♀ but the ♂ has rufous edges to the tail while the ♀ has a white patch at base of tail and a large 74 mm. wing also appears to be of this race.

Obviously the specimens have been mixed up and the sexes wrongly noted. Another ♂ juvenile (without the rufous edges) from Nainital has also been marked ♀ by Major H. S. Walton. On this differences the 6 unsexed birds can be separated into 1 ♂ and 5 ♀♀.

Measurements on p. 130.

1706 **Oenanthe isabellina** (Temminck) (Nubia, N. Africa) Isabelline Chat 2:49

33: 11 ♂♂ 15 ♀♀ 7 o?

1 *Randha, Tanhat*, 2 *Siyahad, Arabia*; 1 *Hawi Plain, Samarra, bank of R. Tigris*, 2 *3 m. from Kut*, 1 *Mudailil, Amara*, 1 *Beled, R. Tigris*, 1 *Tara-i-galligan Mishum*, 1 *Tanb Is., Persian Gulf*; 1 *Hilla 2 m. from Shiraz*, 1 *Bandamir*, 1 *Nahvand, Iran*; 1 *Rohtak, nr. Sib, Persian Baluchistan*; 1 Chaman, 1 Quetta, 1 Shabbaz, 1 Kalat, 1 Karachi; 1 *Zawa, Khotan, Sinkiang, China*; 1 Khardong, Ladak; 1 Ambala, 1 Daturis, Karual dist., Punjab; 1 Meerut, U.P.; 1 Deesa, 1 Radhanpur, Palanpur, 1 Piltan, Mehsana, 1 Bhuj, 1 Rapar, 1 Walaria environs, Anjar dist., 1 Kutch; 1 Gondia, C.P.; 1 Dhond, Poona dist.

♂ No. 2578 from Randha, Tanhat, Arabia obtained by Philby on 22nd April 1940 has the largest wing (105), bill (15) and tarsus (30.3) and may be the form described by Bonaparte from Yemen, but the original description and later remarks are not available.

Measurements on p. 130.

1707 **Oenanthe xanthoprymna kingi** (Hume) (Jodhpur) Redtailed Chat 2:53

21: 7 ♂♂ 10 ♀♀ 4 o?

1 *Muscat, Arabian Peninsula*; 2 *Mishun, Persian Gulf*; 1 *Aliabad, 13 m S.E. of Shiraz*, 1 *Khain, Persia*; 1 *Wahi, 25 m. S.W. of Khozdar*, 1 *Chaman, Baluchistan*; 2 Drosh, Chitral, N.W.F.P., 1 Hasan Abdel, 1 Campbellpur, Attock, Punjab; 1 Sairea, N.W. Himalayas; 1 Bahawalpur Town Env., 1 Yasman, 2 Manthur, Cholistan, Bahawalpur State, 1 Pithoro, Sind; 3 Khavda, Pacham Is., 1 Lakhpat, Kutch.

In four birds from the Persian Gulf, the upper tail feathers are more rufous than in the others, but there is no difference in size, colour, distribution or season.

Measurements on p. 130.

1708 **Oenanthe oenanthe oenanthe** (Linnaeus) (Sweden) Wheatear 2:48

28: 15 ♂♂ 8 ♀♀ 5 o?

3 *Niton, Isle of Wight*; 1 *Holland*; 1 *Tashkent, Uzbek, USSR*; 1 *Siyahad*, 3 *Shaiba, Arabia*; 1 *Tekrit*, 5 *Shatt-el-Adhain, R. Tigris*, 2 *Nahr Umar*, 1 *Basra*, 1 *Bait-al-Khalifa, Samarra*, 4 *Felujah*, 1 *Hilla, R. Euphrates*, 1 *Aquar Quf, Baghdad*, 1 *Margill, Mesopotamia*; 1 Drosh, 1 Chitral, N.W.F.P.

Though many subspecies have been described from different parts of the range covered by the above specimens and there is some variation in colour, it has not been possible to isolate any group. Sp. No. 21397 ♂ from Tashkent is a very clear grey above and almost pure white below which may represent one of the several races described from worn phases of plumage. Also ♂ 20887 collected at Felujah on 23/3/1917 was registered as *O. rostrata* and differs from the others in having a finer bill but considering what Ticehurst said (*JBNHS* 28, p. 389) when examining the birds from Mesopotamia, I think it best to leave it here.

Measurements on p. 130.

1709 **Oenanthe deserti oreophila** (Oberholser) (Ladak) Tibetan Desert Wheatear 2:52

9: 7 ♂♂ (1 juv.) 2 o?

1 *Chaman, Baluchistan*; 1 *Mintaka, Kukturuk, Pamir*, 1 *Goma*, 4400′, *Sinkiang, China*; 2 *Tingri, S. Tibet*; 1 Moulbeck, 3 Chusal, Ladak.

The white on the inner web of the second primary does not reach the quill in all the specimens as required in the key in the HANDBOOK, but the wings average larger, and most of them are marked *oreophila* by earlier workers.

Measurements on p. 130.

1710 **Oenanthe deserti deserti** (Temminck) (Egypt) Central Asian Desert Wheatear 2:51

51: 31 ♂♂ 9 ♀♀ 11 o?

4 *Shatt-el-Adhain, left bank of R. Tigris*, 1 *6 m. from Kut*, 1 *Legail, Euphrates*; 1 *Charbar*; 2 *Tanb Is., Persian Gulf*; 2 *Muscat**, 1* *Pahrah, 17 m. E. of Bampur, Persian Baluchistan*; 1 Wana, Waziristan; 1 Darya Khan, NWFP; 1 Campbellpur, 2 Jullundur, 1* Multan, 1 Ambala, Punjab; 1 Jalor, Jodhpur; 1 Santhanwara, Gwalior State, 3 Meerut, U.P., 3 Bahawalpur Town env., 2 Harsil, Tehri Garhwal, 1 Nepal (?), 1 Karachi, 1 Pethora, 1* Kotri, Sind; 3 Kharirohar, 3 Khawda, Pacham, 1 Walaria, Anjar, Kutch. 3* Patan, Mehsana, 1* Dabka, Baroda; 1 Ratlam, 1 Sangli C.; 1 Bhayander, 1 Andheri, 2 Santa Cruz, 1 Golf Links, Pali Hill, Bandra.

These should be separable from *oreophila* above by the absence of white on the inner web of the second primary — at least not touching the quill — but some such specimens are included in *oreophila* above. 11 others here marked* also have more or less white on the inner web of the second primary but do not differ in size and are left together. The race *atrogularis* described by Blyth from Agra, U.P. accepted in Stuart Baker's FAUNA 2, p. 51 and Vaurie, p. 346 is synonymised with *deserti* in INDIAN HANDBOOK and no attempt is here made to separate them.

Measurements on p. 130.

1711 **Oenanthe finschi barnesi** (Oates) (Baluchistan & Afghanistan eastwards (sic) to Persia = Kandahar) Barnes's Chat 2:75

25: 16 ♂♂ 2 ♀♀ 7 o?

4 *Bait-el-Khalifa, N. of Samarra*, 5 *Shatt-el-Adhain*, 2 *Kazimain, Baghdad*, 1 *Beled, Tigris*; 8 *Mishun, Persian Gulf*; 1 *Shiraz*, 1 *Karaagooch R., over Kavar* 52° 43′E., 29° 8′W. (*Below Shiraz*), *Iran*; 1 *Siyahad, Saudi Arabia*, 1 *Rohat*, 15 *m. S.E. of Khwash, Persian Baluchistan*; 1 *Chaman, Baluchistan*.

Measurements on p. 131.

1712 **Oenanthe picata** (Blyth) (Scinde) Pied Chat (White-bellied)

This species breaks up into 3 phases which are said to be only polymorphic but not subspecific. The males are very different in colour but the female plumages are not yet clearly known.

(a) Phase *picata* 55: 35 ♂♂ 20 ♀♀

1 *R. Tanhat, Yemen, Arabia*; 1 *Tang Gali Gan*; 4 *Mishun*, 1 *Sha Tashin, Persian Gulf*; 1 *Shustan, S. Persia*; 1 *Ansorquad, Persian Baluchistan*; 2 *Harboid, Kalat*, 1 *W. Yornach, Baluchistan*; 1 Drosh, 1 Chitral, NWFP.; 1 Razani N., 1 Boya N., 1 Waziri, S. Waziristan; 1 Harunabad, 1 Bhung, 1 Manthar. Cholistan, 2 Bahawalpur; 1 Kargil, Baltistan, 1 Kashmir; 2 Rawalpindi, 1 Campbellpur, Attock. 1 Rajpura, Patiala, 1 Madhopur, Gurdaspur. 1 Ambala, 2 Jagadhri, 2 Jhelor, Punjab; 1 Meerut, U.P.; 2 Delhi; 1 Miran Shah, 1 Hyderabad, 1 Sind, *1 Alwar, Rajputana; 1 Suruwaya, Gwalior; 1 Jalor, Jodhpur; 1 Dohad, Panch Mahals, 2 Radhanpur N., 1 Patan, Mehsana; 1 Nakaktrama, 4 Bhujia Fort, 1 Bhuj, 1 Devisar Tank, Kutch; 1 Kharaghoda, Gujerat.

As it is presumably not possible to differentiate between the females of *capistrata* and *picata* the 20 females probably include those of both phases. Specimens Nos. 2460 and 2487 are a male and a female obtained and sexed by Sálim Ali in Bahawalpur town environs about three days apart in Jan./Feb. 1939. This is circumstantial evidence that the female is of the phase *picata*, but there is considerable variation in the colour of the females and it is not possible to group this with others with any degree of consistency. All the relevant literature is not available but it would appear that a series of properly sexed males and females obtained in their breeding grounds, may produce some more reasonable explanation. 3 specimens (all 1st week January) marked female from Radhanpur (2 Sálim Ali and 1 Jagadri, A. E. Jones, Ambala) have the features on the upper edge of the breast darkening towards the black of male *picata*, and are either wrongly sexed together with some more 'females' or represent a plumage not noticed earlier, and at an unknown stage of growth. Some explanation appears necessary to understand some of the differences in colour visible among the females.

Measurements on p. 131.

(b) Phase *opistholeuca* (Strickland) (Punjab) Strickland's Chat 2:44

12: 9 ♂♂ 3 ♀♀

3* Ayun, 1 Drosh, 3 Chitral, 1 Nowshera, Peshawar, N.W.F.P.; 2 Campbellpur, Attock, Punjab; 1 Kandu, Pacham Island, Kutch, 1* Bodeli, Baroda.

The three females* (2 Ayun, 1 Bodeli) have the underparts dusky and can be separated from the black of the males.

Measurements on p. 131.

(c) Phase *capistrata* Gould (Sind)

10 ♂♂ (2 by plumage)

1 *Siyahad, Saudi Arabia*; 1 *Chaman, Baluchistan*; 1 Drosh, Chitral, 1 Nowshere, N.W.F.P.; 1 Campbellpur, 1 Taxila, Punjab; 1 Harunabad, Bahawalpur State; 1 Pushkum, Ladakh; 2 *Tashkent, U.S.S.R.*

The males can be separated but the females are no doubt mixed with those under *picata*. Specimen No. 2660 ♂ by plumage from Siyahad, Arabia, has a badly damaged head and it is difficult to be certain if it was the same as in the other nine.

Measurements on p. 131.

1713 **Oenanthe monacha** (Temminck) (Nubia-Luxor) Hooded Chat 2:40

nil.

1714 **Oenanthe alboniger** (Hume) (Stony Hills which divide Kelat from Sind and Mekran Coast) Hume's Chat 2:40

4 ♂♂

1 *Tanger Galli Gan, Mishim Is., Persian Gulf*, 1 *Kaftarak*, 11 *m. east of Shiraz, Iran*; 1 *Gusht*, 42 *m. N.W. of Dizak, Persian Baluchistan*; 1 Gilgit, Kashmir.

Measurements on p. 131.

1715 **Oenanthe pleschanka pleschanka** (Lepechin) (Saratov, Lower Volga) Pleschanka's Chat 2:45

15: 12 ♂♂ (1 by pl.) 1 ♀ 2 o?

1 *Shaiba,* 6 *Shatt-el-adhain, bank of R. Tigris,* 1 *Basra,* 1 *Sheikh Saad, Iraq*; 1 *Shah Talsmn, Persian Gulf*; 1 Ayun, 3 Chitral; 1 Nomal, Liddar Valley, Kashmir.

Measurements on p. 131.

EL **Oenanthe hispanica melanoleuca** (Guldenstadt) (Georgia, Caucasus) Blackeared Spanish Wheatear

4 ♂♂ (2 each white and black throated)

1 *Siyahad, Arabia*; 1 *5 m* downstream of,* 1 *Feluja, R. Euphrates, Iraq*; 1 *Pinetok Pass, Persia*.*

The two white-throated specimens* are dated March (?) while the two with black throats are March and 24 May, the latter from Persia is said to have its organs advanced and evidently breeding.

Measurements on p. 131.

1716 **Chaimarrornis leucocephalus** (Vigors) (Himalaya-Simla-Almora dist.) White-capped Redstart 2:79

40: 23 ♂♂ (4 juv.) 10 ♀♀ (2 juv.) 7 o?

1 Machail 9700′, 2* Drosh, 4 Chitral, N.W.F.P.; 1 Safapur Village, 1 Chinchoti, Kishtwar, Kashmir; 1 Dharmsala, 2 Koti State; 1 Keonthal, 1 Summer Hills, 5 Simla; 2 Pindari Glacier, 1 Daronar, Ranikhet, 1 Lobha, Garhwal; 2 Ramgarh, 1 Rajapur, Mussoorie, U.P.; 2 Godavery, Nepal, 1 Rangpo, Sikkim, 1 Bhutan Duars, 1 Mangdechu, Central Bhutan; 1 Kurseong, Darjeeling Dist.,; 1 Miao, Tirap Div., 1 Mayo, Dibang Valley, Lakhimpur, 1 Naga Hills, 1 N. Cachar; 2 Mishmi Hills, 2 no locality * (1 missing).

In the males all the measurements average longer than in the females, and the overlap in the range of size may to some extent be due to erroneous sexing.

Measurements on p. 131.

Saxicoloides fulicata subspp.

Several races have been described from Indian limits on the depth of colour in the males. The one darker above was accepted as of the nominate race and from Sri Lanka, but the type locality has been settled at Pondicherry (Stresemann, 1952) and this can be separated by the females of Sri Lanka, whence we have no specimens but where I noted them darker than in India (Tissamanuram, 1-4 April 1967) and where the race *leucoptera* (Lesson) is accepted. The birds from along the coast as far north as Nasik on the west and Cumbum in the east through Kerala are all nominate *fulicata.*

1717 **Saxicoloides fulicata cambaiensis** (Latham) (Guzerat, India) Brown-backed Indian Robin 2:111

32: 25 ♂♂ 7 ♀♀

1 Bhajji State, 2 Simla, 1 Kalka, Simla Hills, 1 Patiala State, 2 Ambala, Punjab; 1 Meerut, 4 Delhi; 3 Bharatpur, 1 Hemavas Lake, Pali Dist., Jodhpur, Rajasthan; 1 Deesa, Palanpur, North Gujerat; 1 Wanoti, 1 Bhujia Fort, 1 Devisar Tank, 2 Kutch, 1 Jamnagar, 1 Victoria Park, Bhavnagar, 3 Cambay City environs, Gujerat; 2 Jabalpur, 1 Choral, Indore, C.P.; 1 Sarda R., Hosipur, Kheri dist. 1 Cawnpur, U.P.

The males from the northern part of the range have slightly longer tails than those from the south but it is not possible to separate the specimens available into two geographical areas. Birds from Bhujia Fort (31-12-43), Bhavnagar (19-11-61), Jamnagar (11-2-69) and Delhi (19-1-75) show their upper parts slightly darker than in the others.

Measurements on p. 132.

1718 **Saxicoloides fulicata erythrura** (Lesson) (Bengale) Bengal Black Robin

1 o? Gaya, Bihar.

This bird in female plumage is placed in this group on geographical grounds.

Measurements on p. 132.

1719 **Saxicoloides fulicata intermedia** Whistler & Kinnear (Rahuri, Ahmednagar) Deccan Black Robin

12: 9 ♂♂ 3 ♀♀

1 Bhimashankar, Pune; 1 Utnoor, 1 Nelipaka, 1 Kannad, Hyderabad; 1 Bhanupratappur, Kanker, C.P.; 1 Bengasai, foot of Mahendragiri; 1 Tikerpara, Angul dt.; 1 Konta, 1 Dantewara, 1 Bhopala-

patnam, 1 Rampur State, 1 Barkot Bamra, Orissa.

The introduction of this form *intermedia* has led to much confusion, some being intermediate with nominate *fulicata* and others with *cambaiensis.*

Measurements on p. 132.

1720 **Saxicoloides fulicata fulicata** (Linnaeus) (Pondicherry) Blackbacked Indian Robin 2:109

26: 15 ♂♂ 11 ♀♀

1 Shendurni, E. Khandesh; 2 Ghoti, Nasik; 1 Malad, 1 Andheri, 1 Malabar Hill, 1 Trombay Is., 1 Bombay, 1 Belapur Rd., Thane; 1 Ratnagiri; 2 Atmakur, 3 Cumbum Valley, Kurnool Dist., 2 Nallamalai Range, S. Kurnool; 1 Palkonda Hills, 1 Kodpur, 1 Seshachalam Hills, S. Cuddappah; 1 Madras; 1 Kurumbapatty, 1 Herur, Salem Dist., 3 Perumbavur, Travancore (Kerala).

Measurements on p. 132.

1721 **Saxicoloides fulicata leucoptera** (Lesson) (Ceylon)

nil.

1722 **Monticola saxatilis** (Linnaeus) Switzerland) Rock Thrush 2:177

15: 7 ♂♂ 5 ♀♀ 3 o?

1 *Baghdad*; 1 *Fao, Persian Gulf*; 2 *Duzdop, East Persia*; 2 *River Tanhat, Persia*; 1 *Chinese Turkistan*, 1 *Bulunkul*, 11000′ *Pamirs* (38°N, 73°E); 2 Chitral, Ghairat, 1 Galli, Attock Dt., 1 Lahore, Punjab; 1 Hushtarrahi, Kaur *c.* 160 m.s. of Kalat; 2 near Ornach.

The specimens No. 3783 from Bulunkul, 11000′ Pamirs (38°N, 73°E) dated 16-9-1931 is one of the unsexed and is very pale above and almost unmarked below.

Measurements on p. 132.

1723 **Monticola cinclorhynchus** (Vigors) (Himalayan Mountains-Simla) Blueheaded Rock Thrush 2:171

84: 62 ♂♂ (7 juv., 1 nestling by plumage) 22 ♀♀

1 Chitral, 1 Kashmir Valley; 3 Liddar Valley, 1 Sonamarg, Kashmir; 1 Gama-ki-hatti, Charm State, 1 Keonthal State, 21 Simla, 1 Bargali, Mussle Hills 7300′ N.W.H.; 1 Polo ground, 2 Mussoorie, 2 Karuprayag, 1 Lohaghat, 2 Peora, Almora; 1 Ramgarthi, Nainital; 2 Lambathach, 2 Guptakashi, 1 Garhwal; 1 Darba, 1 Geedam, Bastar Dt., 1 Kamli, Bailadila, C.P., 1 Poona, 2 Mahabaleshwar, 1 Sholapur, 1 Kolapur, 1 Vengurla; 1 Talewadi, Belgaum Dt.; 3 Molem, 1 Canacona, Goa; 2 Jalavli, 1 Karwar, 1 N. Kanara; 4 Mercara, Coorg; 1 Kannanpalli, Gudalur Taluka, Nilgiris; 1 Wynaad, 1 Nelliyampathy Hills, 1 Maraiyur, 1 Kumili, Periyar lake, 1 Murchiston, Ponmudi, Travancore; 1 Anantagiri, 1 Dharakonda, Upper Sileru, Vizagapatnam; 2 Koira, Bonai, Orissa; 1 Anark, Darbhanga; 1 Dentom, Sikkim; 1 Shamgong, C. Bhutan, 2 Kanaun Jaunsar; 2 Nicher 7000′ (RMG?); 1 no locality.

One adult ♂ No. 2582 obtained at Vizagapatnam on 16th March 1975 has a white patch at the bottom of the blue chin.

The females curiously contain no juveniles and according to the literature available the juvenile females are the same as the adults. In addition to spots on the head, the juvenile males have curious differences in the extent of rufous on the underparts, but a shorttailed young nestling taken at Simla on 9th June 1912 has chestnut rump feathers and the white on the wings as in the other males.

Measurements on p. 132.

1724 **Monticola rufiventris** (Jardine & Selby) (Simla) Chestnut-bellied Rock Thrush 2:170

57: 34 ♂♂ (6 juv. by plumage) 22 ♀♀ (5 juv.) 1 (? 3685)

1 Murree Hills, Rawalpindi; 1 Dungagalli, Murree Hills; 1 Thandiani, Huli-Ka-Danna 8000′; 1 Dalhousie; 1 Dharmsala, Punjab; 2 Mahasu, 1 Koti State, 4 Summer Hill, 11 Simla; 1 Dhanaulti, Mussoorie; 1 Monna Khal, Garhwal; 1 Ranibaug, 2 Kumaon, 10 Dakuri, Almora, 1 Nainital, 1 Martam, Rongni Valley, 1 Sikkim, 1 Bhutan Duars, 1 Honka, W. Bhutan; 1 Gomchu, East, 1 Wamrong, East, 1 Rongtong, East, 1 Narphong, East Bhutan; 1 Kurseong, 2 Longview Tea Estate, 1 Darjeeling; 1 *Loikaw, North Shan States,* 3 *Mt. Victoria,* 1 *Penthkel Watershed, Upper Burma*; 1 no locality.

The juvenile male is not described but differs from the females by the blue wings and tails and a varying amount of spots on the head and upperback and chestnut on the rump. The female juveniles have spots on the head and upper back, lack the blue on the wings and the chestnut below. Unsexed No. 3685 from Dakuri, 8900′ Garhwal, differs in having fine streaks on the head and back and is for the moment left with this species.

The males (Mahasul, 7500′ Koti State) have a ring of white round the neck, larger and extending on to the breast in one and with a white spot on the belly in both. Two from Simla differ in a fine line of white spots round the neck.

Measurements on p. 133.

1725 **Monticola solitarius longirostris** (Blyth) (from Scinde to Ferozpore) Iranian Blue Rock Thrush 2:173

11: 9 ♂♂ (2 by plumage) 2 ♀♀

1 *Pang-i-dog*, 1 *Dohuk, Kurdistan*; 1 *Mosul*, 6 *Mishum, Persian Gulf*; 2 *Muscat.*

The males are slightly paler blue than 1726 (*pandoo*) and the females much paler. None of the specimens from Indian limits can be said to be of this form.

Measurements on p. 133.

1726 **Monticola solitarius pandoo** (Sykes) (Ghauts, Dukhun) Indian Blue Rock Thrush 2:175

63: 43 ♂♂ (11 by plumage) 19 ♀♀ (2 by plumage) 1 nestling

7 Chitral, 1 Gilgit, 2 Safapur, 1 Bandipur, Kashmir; 1 Phayang, Dokpo, Ladak; 1 Kurran, Militia, Parachinar, N.W.F.P.; 1 Dunga Galli, Murree Hills; 1 Rawalpindi, Punjab; 1 Keonthal State, 3 Sanjuli, 2 Simla Hills; 1 Almora; 1 Lamba Thach, 2 Garhwal; 1 Delhi; 1 Hamawas Lake, Jodhpur State; 1 Balaram, Palanpur State; 2 Dhari, Amreli Dt., Gujarat; 1 Gawligarh Fort, Chikalda, Berar; 1 Bombay Harbour, 1 Andheri; 1 Trombay Is.; 2 Khandala, W. Ghats 1 Mehda, Satara Dt., 1 Bana, C. P.; 1 Cumbum Valley, Kurnool Dt., 1 Dharwar, 2 Jog; 1 N. Kanara, 1 Karwar, 1 Coonoor, Nilgiris, 1 Top Bunglow, Wynaad; 1 Peerumedu, Travancore, 2 Nilgiri, Orissa, 1 Deothang, East, 1 Mangdechu, Central, 1 Gedu, West Bhutan; 1 Rangpo, Sikkim; 1 Sevoke, Darjeeling Terai, 2 Longview T.E., Darjeeling, 1 Mishmis, Abor country 1 Margherita, Assam; 1 *Pakokku*, 2 *Loikaw, S. Shan States*, 1 *Thayetmyo Dt.*, 1 *Nagaphaw, Prome Dt.*

Measurements on p. 133.

EL **Monticola solitaria philippensis** Muller (Philippines) The Japanese Blue Rock Thrush

1 ♂ *Karimgauk, Henzada dist., Burma.*

The rufous underparts are distinctive.

Measurements on p. 133.

1727 **Myiophonus blighi** (Holdsworth) (Banks of Lemastota-Oya, 4200′, Haputale Dist., Uva, Ceylon) Ceylon Whistling Thrush 2:182

nil.

1728 **Myiophonus horsfieldii horsfieldii** (Vigors) (Himalayan mountains, restricted to Malabar by Baker, 1923, Hand-list: 93) Malabar Whistling Thrush 2:178

14: 8 ♂♂ 3 ♀♀ 3 o? (1 nestling)

1 Mahal, Surat Dangs; 1 Chikalda, Berar; 1 Kanheri Caves, Bombay; 3 Khandala, 1 Western Ghats; 1 Honametti Estate, Mysore; 1 Patoli, 1 Supa Petha, Kanara; 1 Gersoppa, Jog falls; 3 Palni Ghats.

Measurements on p. 133.

1729 **Myiophonus caeruleus temminckii** (Vigors) (Himalayan Mountains = Simla = Almora dist.) Himalaya Whistling Thrush 2:180

45: 23 ♂♂ (3 juv.) 14 ♀♀ (1 juv.) 8 o?

1 *Tashkent, U.S.S.R.*; 1 Chitral; 1 Campbellpur, 1 Jhelum, 1 Dharmsala Punjab; 1 Koti State; 1 Kaudaghat, Patiala State, 5 Simla, N.W.H.; 1 Rampur, Himachal Pradesh; 2 Adabadri, 1 Kedarnath, 1 Badrinath, Garhwal; 5 Dakuri, Almora, 1 Mornaula, 2 Kumaon, 2 Bhawati, Nainital Dt.; 1 Chalna Khel, 1 Godaveri, 1 Nepal; 1 Rangpo, Sikkim; 1 Chumbi, 4 Long View T.E., Darjeeling; 2 Kurseong Div., 1 Margherita, 1 Pishna Camp, Goalpara, Assam; 1 Hungreon, N. Cachar Hills, 1 N. Cachar; 1 Kurbia (?); 1 *Hluia Chaung, Thayetmyo Dt.; Burma*; 1 no locality(?)

Sp. ♀ No. 3793 bears two labels saying "Dec. 1890, N. Kanara, E H. Aitkin") which if correct extends the range of the species considerably southwards, but in all probability represents a loss of the original labels and an error and mix-up in subsequent labels.

Measurements on p. 134.

1730 **Myiophonus caeruleus eugenei** (Hume) (Thayetmyo and Western Pegu Hills) Burmese Whistling Thrush 2:181

3: 1 ♂ 1 ♀ 1 o?

1 Tezu, Lohit Valley, Mishmi Hills, Upper Assam; 1 *Popa Myengyi, Upper Burma,* 1 *Taunggyi, S. Shan State.*

Measurements on p. 134.

Pt. 33

1692 **Cercomela fusca**

	Wing	Bill	Tarsus	Tail
♂♂ (8)	88-95 av. 90.1 (IH 87-95	13.9-15.8 av. 14.7 from skull 18-19	23.5-28.2 av. 25.3 25-27	64-73 av. 68.1 65-72)
♀♀ (9)	83-94 av. 86.5 (IH 85-90	13-14.5 av. 13.9 from skull 18-19	23.5-26.5 av. 24.8 25-26	64-70 av. 66.7 61-69)
EL **Saxicola rubetra**				
♂ (1)	74 (BHB 74-81	11.3 from skull 13.5-15	20.7 21-24	40 43-48)
♀♀ (3)	73, 74, 75 (BHB 73-80	9.6, 10.7, 11 —	19.2, 20.2, 21.6 —	45, 45, 46 —)
1694 **Saxicola insignis**				
♂♂ (4)	85, 86, 88, 88 (IH ♂♀ 83-92	13, 13.1, 13.5, 13.5 13	25.5, 26, 26.5, 26.9 27	50, 52, 55, 56 49-54)
♀♀ (3)	85, 88, 90	11.6, 12.9, 13.5	25.6, 25.8, 26	52, 53, 55
1695-98 **Saxicola torquata** subspp. & ELs.				
♂♂				
1695 *maura* (5) (Dementiev	72-75 av. 73.4 64-73 av. 67.7)	10.7-11 av. 10.8	16.9-20.6 av. 18.3	41-51 av. 46.8
1696 *przewalskii* (9)	74-77 av. 75.2 (IH 71-76	9.7-11.5 av. 10.6 from skull 15-17	20.5-23.4 av. 22.3 —	49-56 av. 53.4 53-57)
1697 *indica* (56)	62-73 av. 68.05 (IH 64-73	9.4-12.4 av. 10.3 from skull 13-14	17.8-22 av. 19.9 21-23	42-53 av. 46.5 46-53)
1698 *stejnegeri* (7)	67-72 av. 68.8 (IH 65-70 av. 67.5	9.4-12.4 av. 10.8 from skull *c.* 14)	17.1-23.7 av. 21	43-52 av. 47.6
EL. *rubicola* (5) (Dementiev	64-66 av. 64.8 63-67 av. 65.1	10-11.7 av. 10.7 —	17.5-22.1 av. 20.3 —	43-48 av. 46 —)
EL. *armenica* (2) (Dementiev	74, 74 70-75.6)	10.5, 11.2 —	20.5, 20.9 —	48, 49 —
EL. *variegata* (3) (Dementiev	71, 72, 72 66-72	10.1, 11.4, 12.3 —	20.6, 21.4, 21.5 —	48, 50, 50 —)

1695-98 **Saxicola torquata** subspp. & ELs (contd.)

♀♀	*Wing*	*Bill*	*Tarsus*	*Tail*
maura (3)	70, 73, 74	9.3, 10.6, 11.4	17.6, 18.2, 20.5	48, 50, 51
(Dementiev	64-71 av. 67	—	—	—)
indica (31)	62-71 av. 65.7	9-11.7 av. 10.4	17.8-22.7 av. 20.2	41-51 av. 45.7
	(IH 62-70	from skull 13-14	21-23	44-50)
stejnegeri (6)	65-71 av. 67.8	9.8-11.6 av. 10.8	20.5-22.6 av. 21.3	46-52 av. 48.5
EL	(Dementiev 64-68	from skull *c.* 14	—	—)
rubicola (6)	61-65 av. 63.5	9.6-11.1 av. 10.6	19.5-22.5 av. 21.3	42-46 av. 44
	(Dementiev 62-65	—	—	—)
armenica (1)	73	11.7	20.5	49
variegata (2)	67, 68	10.8, 11	20.2, —	47(2)

1699 **Saxicola leucura**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (10)	63-72 av. 68.5	9.5-12 av. 10.6	18.7-22.5 av. 21.3	44-51 av. 47.7
	(IH 67-71	from skull 14-15	*c.* 21	49-52) (CBT)
♀♀ (2)	63, 66	11.1, 11.4	20.2, 21.3	46, —
	(IH 65-67	from skull 14-15	*c.* 21	48-52 (CBT)

1700-2 **Saxicola caprata** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1700 *bicolor* (35)	67-76 av. 70.5	9-11.9 av. 10.5	17-22.3 av. 20.1	45-54 av. 49.4
	(IH 66-77	from skull 13-15	20-24	50-55)
1701 *burmanica* (22)	67-74 av. 70.5	9-11.8 av. 10.5	18.2-22.5 av. 20.4	46-54 av. 49.3
	(IH 67-77	13-15	20-22	48-62)
1702 *nilgiriensis* (10)	73-78 av. 76	10.5-12 av. 11.6	19.8-26 av. 22.4	50-55 av. 52.7
	(IH 73-79	from skull 15-17	25-27	60-67)
♀♀				
bicolor (17)	65-73 av. 69.5	9.9-11.5 av. 10.6	19-23.3 av. 20.6	46-52 av. 48.6
	(IH 64-75	from skull 13-15	20-23	49-53)
burmanica (12)	65-71 av. 68.8	9.7-12.7 av. 11.3	19.6-25.8 av. 20.9	44-50 av. 47.3
	(IH 68-72	from skull 13-15	20-22	47-51)
nilgiriensis (3)	70, 73, 75	10.5, 11.3, 12.6	20.9, 20.9, 22.5	48, 52, 53
	(IH 69-75	from skull 15-16	25-26	59-63)

Pt. 33

1692 **Cercomela fusca**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (8)	88-95 av. 90.1	13.9-15.8 av. 14.7	23.5-28.2 av. 25.3	64-73 av. 68.1
	(IH 87-95	from skull 18-19	25-27	65-72)
♀♀ (9)	83-94 av. 86.5	13-14.5 av. 13.9	23.5-26.5 av. 24.8	64-70 av. 66.7
	(IH 85-90	from skull 18-19	25-26	61-69)

EL **Saxicola rubetra**

♂ (1)	74	11.3	20.7	40
	(BHB 74-81	from skull 13.5-15	21-24	43-48)
♀♀ (3)	73, 74, 75	9.6, 10.7, 11	19.2, 20.2, 21.6	45, 45, 46
	(BHB 73-80	—	—	—)

1694 **Saxicola insignis**

♂♂ (4)	85, 86, 88. 88	13, 13.1, 13.5, 13.5	25.5, 26. 26.5, 26.9	50, 52. 55, 56
	(IH ♂♀ 83-92	13	27	49-54)
♀♀ (3)	85, 88. 90	11.6, 12.9, 13.5	25.6, 25.8, 26	52. 53, 55

1695-98 **Saxicola torquata** subspp. & ELs.

♂♂				
1695 *maura* (5)	72-75 av. 73.4	10.7-11 av. 10.8	16.9-20.6 av. 18.3	41-51 av. 46.8
(Dementiev	64-73 av. 67.7)			
1696 *przewalskii* (9)	74-77 av, 75.2	9.7-11.5 av. 10.6	20.5-23.4 av. 22.3	49-56 av. 53.4
	(IH 71-76	from skull 15-17	—	53-57)
1697 *indica* (56)	62-73 av. 68.05	9.4-12.4 av. 10.3	17.8-22 av, 19.9	42-53 av. 46.5
	(IH 64-73	from skull 13-14	21-23	46-53)
1698 *stejnegeri* (7)	67-72 av. 68.8	9.4-12.4 av. 10.8	17.1-23.7 av. 21	43-52 av. 47.6
	(IH 65-70 av. 67.5	from skull *c.* 14)		
EL. *rubicola* (5)	64-66 av. 64.8	10-11.7 av. 10.7	17.5-22.1 av. 20.3	43-48 av. 46
(Dementiev	63-67 av. 65.1	—	—	—)
EL. *armenica* (2)	74, 74	10.5. 11.2	20.5, 20.9	48, 49
(Dementiev	70-75.6)	—	—	—
EL. *variegata* (3)	71, 72, 72	10.1, 11.4, 12.3	20.6, 21.4, 21.5	48, 50, 50
(Dementiev	66-72	—	—	—)

1695-98 **Saxicola torquata** subspp. & ELs (contd.)

♀♀	*Wing*	*Bill*	*Tarsus*	*Tail*
maura (3)	70, 73, 74	9.3, 10.6, 11.4	17.6, 18.2, 20.5	48, 50, 51
(Dementiev	64-71 av. 67	—	—	—)
indica (31)	62-71 av. 65.7	9-11.7 av. 10.4	17.8-22.7 av. 20.2	41-51 av. 45.7
	(IH 62-70	from skull 13-14	21-23	44-50)
stejnegeri (6)	65-71 av. 67.8	9.8-11.6 av. 10.8	20.5-22.6 av. 21.3	46-52 av. 48.5
EL	(Dementiev 64-68	from skull *c.* 14	—	—)
rubicola (6)	61-65 av. 63.5	9.6-11.1 av. 10.6	19.5-22.5 av. 21.3	42-46 av. 44
	(Dementiev 62-65	—	—	—)
armenica (1)	73	11.7	20.5	49
variegata (2)	67, 68	10.8. 11	20.2, —	47(2)

1699 **Saxicola leucura**

♂♂ (10)	63-72 av. 68.5	9.5-12 av. 10.6	18.7-22.5 av. 21.3	44-51 av. 47.7
	(IH 67-71	from skull 14-15	*c.* 21	49-52)
				(CBT)
♀♀ (2)	63, 66	11.1, 11.4	20.2, 21.3	46, —
	(IH 65-67	from skull 14-15	*c.* 21	48-52
				(CBT)

1700-2 **Saxicola caprata** subspp.

♂♂				
1700 *bicolor* (35)	67-76 av. 70.5	9-11.9 av. 10.5	17-22.3 av. 20.1	45-54 av. 49.4
	(IH 66-77	from skull 13-15	20-24	50-55)
1701 *burmanica* (22)	67-74 av. 70.5	9-11.8 av. 10.5	18.2-22.5 av. 20.4	46-54 av. 49.3
	(IH 67-77	13-15	20-22	48-62)
1702 *nilgiriensis* (10)	73-78 av. 76	10.5-12 av. 11.6	19.8-26 av. 22.4	50-55 av. 52.7
	(IH 73-79	from skull 15-17	25-27	60-67)
♀♀				
bicolor (17)	65-73 av. 69.5	9.9-11.5 av. 10.6	19-23.3 av. 20.6	46-52 av. 48.6
	(IH 64-75	from skull 13-15	20-23	49-53)
burmanica (12)	65-71 av. 68.8	9.7-12.7 av. 11.3	19.6-25.8 av. 20.9	44-50 av. 47.3
	(IH 68-72	from skull 13-15	20-22	47-51)
nilgiriensis (3)	70, 73, 75	10.5. 11.3, 12.6	20.9, 20.9, 22.5	48. 52, 53
	(IH 69-75	from skull 15-16	25-26	59-63)

1704 **Saxicola jerdoni**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (3)	65, 66, 69 (Baker 67-69	10.8, 11.4, 11.7 11	20, 22, 22.5 23	56, 61, 64 61-69)

1705 **Saxicola ferrea**

♂♂ 52 (8p1)	64-72 av. 68	9.2-12.6 av. 10.6	18.4-22.7 av. 20.2	53-66 av. 58.5
♀♀ 27 (5p1)	63-70 av. 65.9 (IH ♂♀ 64-71	9.3 12.4 av. 10.5 from skull 14-16	17.5-21.8 av. 19.4 21-24	52-64 av. 56.2 54-65)

1706 **Oenanthe isabellina**

♂♂ (11)	97-105 av. 99.6 (IH 98-104	12.5-15.5 av. 14.2 from skull 18-20	27-30.3 av. 28.2 30-31	52-62 av. 57.6 56-62)
♀♀ (15)	91-101 av. 95.7 (IH 92-96	11.7-15.8 av. 14 from skull 19-20	23.1-31.4 av. 28.2 29-30	54-62 av. 56.4 51-55)

1707 **Oenanthe xanthoprymna kingi**

♂♂ (7)	87-96 av. 90.4 (IH 92-97	14.1-15.6 av. 14.7 from skull 18-20	22.2-25.4 av. 23.3 25-26	53-61 av. 58.4 56-65)
♀♀ (10)	87-95 av. 90.4 (IH 90-92	12.7-16.3 av. 14 from skull 18-20	20.6-25.3 av. 23.4 25-26	55-61 av. 58.2 59-64)

1708 **Oenanthe oenanthe oenanthe**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (15)	93-101 av. 97.2 (IH 87-101 av. 94.4	12.8-14.4 av. 13.3 —	25-29.5 av. 26.7 (Dementiev)	49-58 av. 54.1 50-60)
♀♀ (8)	94-95 av. 94.2	12.1-13.9 av. 12.9	24.4-27.1 av. 26.6	48-55 av. 52.2

1709/10 **Oenanthe deserti** subspp.

♂♂ 1709 *oreophila* (7)	96-103 av. 99.6 (IH 96-106	13.7-15.4 av. 14.3 18-19	24.6-26.1 av. 25.3 26	60-65 av. 63.1 65-71)
1710 *deserti* (31)	91-100 av. 94.4 (IH 94-99	11.3-15.3 av. 12.9 16-20	22.2-28.7 av. 24.6 25-27	57-69 av. 61.3 60-61
♀♀ 1710 *deserti* (9)	87-98 av. 92.4 (IH 87-94	11-13.5 av. 12.4 16-18	23.1-27.2 av. 24.6 25-27	57-65 av. 59.8 54-64

1711 **Oenanthe finschi barnesi**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (16)	88-93 av. 90.7	12.7-14.7 av. 13.5	21.5-27 av. 23.5	52-62 av. 58
	(IH 84-96	—	24-26	60-70)
♀♀ (2)	85, 92	12.8, 13.5	23, 23.3	51, 60
	(IH 82-90		24-26	53-65)

1712 **Oenanthe picata**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ phase				
picata (35)	85-97 av. 91.3	11.2-14.5 av. 12.6	20.8-25.5 av. 23.2	58-70 av. 62.9
	(IH 86-98	from skull 15-18	25-26	60-73)
opistholeuca (9)	87-94 av. 91.7	10.7-14.2 av. 12.4	21.8-26.5 av. 23.5	62-66 av. 64.4
capistrata (10)	90-96 av. 92.4	10.9-13.1 av. 12.2	19.1-24.7 av. 22.1	58-68 av. 63.4
♀♀ phase				
picata (20)	84-89 av. 86.7	10.9-13.7 av. 12.5	20.3-23.8 av. 22.4	58-66 av. 60.4
	(IH 86-95	from skull 14-18	22-26	60-74)
opistholeuca (3)	84, 85, 87	12.1, 12.7, 14.2	20.7, 20.9, 23.3	58, 61, 64

1714 **Oenanthe alboniger**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (4)	98, 100, 107, 108	14.4, 14.6, 15(2)	22, 23, 24.1, 24.2	64(2), 68, 69
	(IH 100-108	from skull 20-22	—	62-76)

1715 **Oenanthe pleschanka pleschanka**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (12) (1 by pl.)	89-99 av. 94	10.3-14.6 av. 11.9	18.4-23.9 av. 20.9	57-64 av. 60
	(IH 86-98	from skull 15-17	22-23	57-65)
♀ (1)	87	12.4	22.6	58
	(IH 84-93	from skull 15-17	22-23	56-60)

EL **Oenanthe hispanica melanoleuca**

	Wing	*Bill*	*Tarsus*	*Tail*
♀♀ (4)	88, 88, 90, 93	12.1, 12.7, 13.1, —	19, 20.5, 22.2, 22.8	53, 58, 58, 62
	(Dementiev 88.3-94)			

1716 **Chaimarornis leucocephalus**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (19)	79-102 av. 96.3	11.9-15.5 av. 13.2	25.4-31.8 av. 29.2	65-80 av. 73.1
	(IH 91-103	from skull 17-19	32-33	79-82)
♀♀ (8)	88-102 av. 92.6	11.4-15 av. 13.2	23.5-27.2 av. 26.1	65-77 av. 70.2
	(IH 86-98	from skull 17-19	32-33	69-76)

1704 **Saxicola jerdoni**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (3)	65, 66, 69	10.8, 11.4, 11.7	20, 22, 22.5	56, 61, 64
	(Baker 67-69	11	23	61-69)

1705 **Saxicola ferrea**

♂♂ 52 (8pl)	64-72 av. 68	9.2-12.6 av. 10.6	18.4-22.7 av. 20.2	53-66 av. 58.5
♀♀ 27 (5pl)	63-70 av. 65.9	9.3 12.4 av. 10.5	17.5-21.8 av. 19.4	52-64 av. 56.2
	(IH ♂♀ 64-71	from skull 14-16	21-24	54-65)

1706 **Oenanthe isabellina**

♂♂ (11)	97-105 av. 99.6	12.5-15.5 av. 14.2	27-30.3 av. 28.2	52-62 av. 57.6
	(IH 98-104	from skull 18-20	30-31	56-62)
♀♀ (15)	91-101 av. 95.7	11.7-15.8 av. 14	23.1-31.4 av. 28.2	54-62 av. 56.4
	(IH 92-96	from skull 19-20	29-30	51-55)

1707 **Oenanthe xanthoprymna kingi**

♂♂ (7)	87-96 av. 90.4	14.1-15.6 av. 14.7	22.2-25.4 av. 23.3	53-61 av. 58.4
	(IH 92-97	from skull 18-20	25-26	56-65)
♀♀ (10)	87-95 av. 90.4	12.7-16.3 av. 14	20.6-25.3 av. 23.4	55-61 av. 58.2
	(IH 90-92	from skull 18-20	25-26	59-64)

1708 **Oenanthe oenanthe oenanthe**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (15)	93-101 av. 97.2	12.8-14.4 av. 13.3	25-29.5 av. 26.7	49-58 av. 54.1
	(IH 87-101 av. 94.4	—	(Dementiev)	50-60)
♀♀ (8)	94-95 av. 94.2	12.1-13.9 av. 12.9	24.4-27.1 av. 26.6	48-55 av. 52.2

1709/10 **Oenanthe deserti** subspp.

♂♂				
1709 *oreophila* (7)	96-103 av. 99.6	13.7-15.4 av. 14.3	24.6-26.1 av. 25.3	60-65 av. 63.1
	(IH 96-106	18-19	26	65-71)
1710 *deserti* (31)	91-100 av. 94.4	11.3-15.3 av. 12.9	22.2-28.7 av. 24.6	57-69 av. 61.3
	(IH 94-99	16-20	25-27	60-61
♀♀				
1710 *deserti* (9)	87-98 av. 92.4	11-13.5 av. 12.4	23.1-27.2 av. 24.6	57-65 av. 59.8
	(IH 87-94	16-18	25-27	54-64

1711 **Oenanthe finschi barnesi**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂ (16)	88-93 av. 90.7	12.7-14.7 av. 13.5	21.5-27 av. 23.5	52-62 av. 58
	(IH 84-96	—	24-26	60-70)
♀♀ (2)	85, 92	12.8, 13.5	23, 23.3	51, 60
	(IH 82-90		24-26	53-65)

1712 **Oenanthe picata**

♂♂ phase				
picata (35)	85-97 av. 91.3	11.2-14.5 av. 12.6	20.8-25.5 av. 23.2	58-70 av. 62.9
	(IH 86-98	from skull 15-18	25-26	60-73)
opistholeuca (9)	87-94 av. 91.7	10.7-14.2 av. 12.4	21.8-26.5 av. 23.5	62-66 av. 64.4
capistrata (10)	90-96 av. 92.4	10.9-13.1 av. 12.2	19.1-24.7 av. 22.1	58-68 av. 63.4
♀♀ phase				
picata (20)	84-89 av. 86.7	10.9-13.7 av. 12.5	20.3-23.8 av. 22.4	58-66 av. 60.4
	(IH 86-95	from skull 14-18	22-26	60-74)
opistholeuca (3)	84, 85, 87	12.1, 12.7, 14.2	20.7, 20.9, 23.3	58, 61, 64

1714 **Oenanthe alboniger**

♂♂ (4)	98, 100, 107, 108	14.4, 14.6, 15(2)	22, 23, 24.1, 24.2	64(2), 68, 69
	(IH 100-108	from skull 20-22	—	62-76)

1715 **Oenanthe pleschanka pleschanka**

♂♂ (12) (1 by pl.)	89-99 av. 94	10.3-14.6 av. 11.9	18.4-23.9 av. 20.9	57-64 av. 60
	(IH 86-98	from skull 15-17	22-23	57-65)
♀ (1)	87	12.4	22.6	58
	(IH 84-93	from skull 15-17	22-23	56-60)

EL **Oenanthe hispanica melanoleuca**

♀♀ (4)	88, 88, 90, 93	12.1, 12.7, 13.1, —	19, 20.5, 22.2, 22.8	53, 58, 58, 62
	(Dementiev 88.3-94)			

1716 **Chaimarornis leucocephalus**

♂♂ (19)	79-102 av. 96.3	11.9-15.5 av. 13.2	25.4-31.8 av. 29.2	65-80 av. 73.1
	(IH 91-103	from skull 17-19	32-33	79-82)
♀♀ (8)	88-102 av. 92.6	11.4-15 av. 13.2	23.5-27.2 av. 26.1	65-77 av. 70.2
	(IH 86-98	from skull 17-19	32-33	69-76)

1717-21 **Saxicoloides fulicata** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1717 *cambaiensis* (25)	71-81 av. 75.2	11.4-14.7 av. 13	22.5-26.8 av. 24.8	63-75 av. 67.5
	(IH 72-80	from skull 14-16	25-28	65-78)
1719 *intermedia* (9)	67-74 av. 72.9	11.3-14.5 av. 12.6	23.4-27.3 av. 25.2	59-68 av. 63.9
	(IH 70-78	from skull 14-16	25-27	60-67)
1720 *fulicata*(15)	71-78 av. 75.1	11.4-14.5 av. 12.8	23.4-29 av. 25.5	57-71 av. 64
	(IH 70-80	from skull 14-16	24-27	60-67)
♀♀				
1717 *cambaiensis* (7)	70-74 av. 71.1	11.2-15.5 av. 12.9	22.8-25.3 av. 24.2	60-65 av. 62.5
	(IH 69-79	from skull 14-16	25-27	61-70)
1718 *erythrura* (1) by pl.	70	11.6	22.4	61
	(IH ♂♀ 69, 70)			
1719 *intermedia* (3)	64, 70, 74	12.8, 13, 14.8	21.7, 24.3, 24.5	60, 62, 64
	(IH 68-72	from skull 14-16	25-27	58-61)
1720 *fulicata* (11)	69-75 av. 71	10.6-13.9 av. 12.3	23.2-27 av. 24.9	56-60 av. 58.6
	(IH 69-75	from skull 13-16	23-25	58-66)

1722 **Monticola saxatilis**

	Wing	Bill	Tarsus	Tail
♂♂ (7)	117-125 av. 121.4	17.4-21.2 av. 19.5	23.5-29.3 av. 25.8	55-65 av. 60
	(IH 113-126	from skull 24-26	—	62-70)
♀♀ (5)	115-125 av. 119.6	18.5-20.5 av. 19.4	23.6-27.5 av. 25.5	56-62 av. 59.2
	(IH 113-119	from skull 24-26	(Dementiev)	—)

1723 **Monticola cinclorhynchus**

	Wing	Bill	Tarsus	Tail
♂♂				
Adult (54)	97-107 av. 101.3	16.3-20.5 av. 18.6	19.4-25.9 av. 22.5	61-71 av. 66.4
	(IH 99-108	from skull 23-25	25-26	65-71)
juv. (7)	99-104 av. 100.4	17.2-20.6 av. 18.7	21.7-23 av. 22.17	63-70 av. 66.3
♀♀ 22	96-101 av. 98.1	17-19 av. 17.97	18.2-25.2 av. 22.5	61-70 av. 65.5
	(IH 96-103	from skull 22-25	24-27	64-71)

1724 **Monticola rufiventris**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
Adult (28)	119-128 av. 122.96	16-26 av. 20.2	22-27 av. 24.8	88-99 av. 93.8
	(IH 117-130	from skull 24-28	26-30	96-105)
juveniles (6)	122-125 av. 122.5	17.6-20.5 av. 19.08	23.2-25.9 av. 24.5	92-102 av. 95.2
♀♀				
Adult (17)	112-122 av. 118.29	17-21.6 av. 18.3	21-27 av. 24.07	86-96 av. 92.9
	(IH 111-124	from skull 26-28	26-30	96-100)
juveniles (5)	113-120 av. 117.4	16.8-20 av. 17.96	22.3-25.6 av. 24	90-96 av. 93.4

1725-26 **Monticola solitarius** subsp. + EL

♂♂				
1725 *longirostris* (9)	118-125 av. 121.2	21.5-25.9 av. 23.1	24.5-27.9 av. 26.5	76-84 av. 79.2
	(IH 116-127)			
1726 *pandoo* (43)	114-129 av. 120.8	19-24 av. 21.3	22-31 av. 25.6	64-86 av. 78
	(IH 111-136	from skull 25-29	25-32	77-95)
EL *philippensis* (1)	121	21.5	27.5	72
	(Baker 112-126)			
♀♀				
longirostris (2)	117, 119	21.5 (2)	23.6, 26.5	67, 74
	(IH 113-125)			
pandoo (19)	112-122 av. 116.1	19.3-24 av. 21.8	23-28.8 av. 25.6	72-87 av. 77.89
	(IH 112-121	from skull 25-29	25-30	75-88)

1728 **Myiophonus horsfieldii**

♂♂ (8)	144-162 av. 154	24.5-27.5 av. 26.6	41.5-48.5 av. 44	100-118 av. 105.3
	(IH 152-165	from skull 32-34	39-49	107-121
♀♀ (3)	144 (2), 159	28, 28.3, 28.5	41, 41.1, 42.8	95, 101, 102
	(IH 143-151	30-32	39-49	94-108)

1717-21 **Saxicoloides fulicata** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1717 *cambaiensis* (25)	71-81 av. 75.2	11.4-14.7 av. 13	22.5-26.8 av. 24.8	63-75 av. 67.5
	(IH 72-80	from skull 14-16	25-28	65-78)
1719 *intermedia* (9)	67-74 av. 72.9	11.3-14.5 av. 12.6	23.4-27.3 av. 25.2	59-68 av. 63.9
	(IH 70-78	from skull 14-16	25-27	60-67)
1720 *fulicata*(15)	71-78 av. 75.1	11.4-14.5 av. 12.8	23.4-29 av. 25.5	57-71 av. 64
	(IH 70-80	from skull 14-16	24-27	60-67)
♀♀				
1717 *cambaiensis* (7)	70-74 av. 71.1	11.2-15.5 av. 12.9	22.8-25.3 av. 24.2	60-65 av. 62.5
	(IH 69-79	from skull 14-16	25-27	61-70)
1718 *erythrura* (1) by pl.	70	11.6	22.4	61
	(IH ♂ ♀ 69, 70)			
1719 *intermedia* (3)	64, 70, 74	12.8, 13, 14.8	21.7, 24.3, 24.5	60, 62, 64
	(IH 68-72	from skull 14-16	25-27	58-61)
1720 *fulicata* (11)	69-75 av. 71	10.6-13.9 av. 12.3	23.2-27 av. 24.9	56-60 av. 58.6
	(IH 69-75	from skull 13-16	23-25	58-66)

1722 **Monticola saxatilis**

♂♂ (7)	117-125 av. 121.4	17.4-21.2 av. 19.5	23.5-29.3 av. 25.8	55-65 av. 60
	(IH 113-126	from skull 24-26	—	62-70)
♀♀ (5)	115-125 av. 119.6	18.5-20.5 av. 19.4	23.6-27.5 av. 25.5	56-62 av. 59.2
	(IH 113-119	from skull 24-26	(Dementiev)	—)

1723 **Monticola cinclorhynchus**

♂♂	*Wing*	*Bill*	*Tarsus*	*Tail*
Adult (54)	97-107 av. 101.3	16.3-20.5 av. 18.6	19.4-25.9 av. 22.5	61-71 av. 66.4
	(IH 99-108	from skull 23-25	25-26	65-71)
juv. (7)	99-104 av. 100.4	17.2-20.6 av. 18.7	21.7-23 av. 22.17	63-70 av. 66.3
♀♀ 22	96-101 av. 98.1	17-19 av. 17.97	18.2-25.2 av. 22.5	61-70 av. 65.5
	(IH 96-103	from skull 22-25	24-27	64-71)

1724 **Monticola rufiventris**

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
Adult (28)	119-128 av. 122.96	16-26 av. 20.2	22-27 av. 24.8	88-99 av. 93.8
	(IH 117-130	from skull 24-28	26-30	96-105)
juveniles (6)	122-125 av. 122.5	17.6-20.5 av. 19.08	23.2-25.9 av. 24.5	92-102 av. 95.2
♀♀				
Adult (17)	112-122 av. 118.29	17-21.6 av. 18.3	21-27 av. 24.07	86-96 av. 92.9
	(IH 111-124	from skull 26-28	26-30	96-100)
juveniles (5)	113-120 av. 117.4	16.8-20 av. 17.96	22.3-25.6 av. 24	90-96 av. 93.4

1725-26 **Monticola solitarius** subsp. + EL

♂♂				
1725 *longirostris* (9)	118-125 av. 121.2	21.5-25.9 av. 23.1	24.5-27.9 av. 26.5	76-84 av. 79.2
	(IH 116-127)			
1726 *pandoo* (43)	114-129 av. 120.8	19-24 av. 21.3	22-31 av. 25.6	64-86 av. 78
	(IH 111-136	from skull 25-29	25-32	77-95)
EL *philippensis* (1)	121	21.5	27.5	72
	(Baker 112-126)			
♀♀				
longirostris (2)	117, 119	21.5 (2)	23.6, 26.5	67, 74
	(IH 113-125)			
pandoo (19)	112-122 av. 116.1	19.3-24 av. 21.8	23-28.8 av. 25.6	72-87 av. 77.89
	(IH 112-121	from skull 25-29	25-30	75-88)

1728 **Myiophonus horsfieldii**

♂♂ (8)	144-162 av. 154	24.5-27.5 av. 26.6	41.5-48.5 av. 44	100-118 av. 105.3
	(IH 152-165	from skull 32-34	39-49	107-121
♀♀ (3)	144 (2), 159	28, 28.3, 28.5	41, 41.1, 42.8	95, 101, 102
	(IH 143-151	30-32	39-49	94-108)

1729/30 **Myiophonus caeruleus** subspp.

	Wing	*Bill*	*Tarsus*	*Tail*
♂♂				
1729 *temminckii* (20)	155-190 av. 171.9	24-30 av. 27.4	46.8-58 av. 52.7	108-151 av. 123.2
juveniles (3)	135, 172, 172	23.1, 25, 26.2	51, 53.1, 55.5	60, 109, 120
	(IH 167-192	from skull 33-36	50-55	129-140)
1730 *eugenei* (1)	173	26.5	50.5	116
	(IH as in 1729)			
♀♀				
temmickii (13)	160-180 av. 170.2	25.3-29 av. 27.1	44-57 av. 50.5	114-143 av. 124.2
juvenile (1)	173	24.5	52.5	128
	(IH 155-184	from skull 33-35	50-55	120-127)
eugenei (1)	164	28	50.5	110

(*to be continued*)

1729/30 **Myiophonus caeruleus** subspp.

	Wing	Bill	Tarsus	Tail
♂♂				
1729 *temminckii* (20)	155-190 av. 171.9	24-30 av. 27.4	46.8-58 av. 52.7	108-151 av. 123.2
juveniles (3)	135, 172, 172	23.1, 25, 26.2	51, 53.1, 55.5	60, 109, 120
	(IH 167-192	from skull 33-36	50-55	129-140)
1730 *eugenei* (1)	173 (IH as in 1729)	26.5	50.5	116
♀♀				
temmickii (13)	160-180 av. 170.2	25.3-29 av. 27.1	44-57 av. 50.5	114-143 av. 124.2
juvenile (1)	173	24.5	52.5	128
	(IH 155-184	from skull 33-35	50-55	120-127)
eugenei (1)	164	28	50.5	110

(*to be continued*)

OBSERVATIONS ON THE REPRODUCTION AND ASSOCIATED PHENOMENA IN THE MALE FRUIT BAT, *CYNOPTERUS SPHINX* (VAHL) IN CENTRAL INDIA[1]

Satwant Sandhu[2]

(*With four text-figures*)

Males of *Cynopterus sphinx* in Central India experience two periods of sexual activity, once during September-October and a second time during February-March with a short period of regression during November-December and a longer sexually quiescent period between March and September. The regressed adult testis may weigh less than the testis of the animals approaching their first sexual season. Animals born during June-July experience their first sexual season at the age of 15 to 16 months whereas those born in February-March experience their first sexual season at the age of 19 to 20 months. Sexual maturity or otherwise cannot be determined on the basis of the body weight of the animals.

INTRODUCTION

A study of the breeding biology of bats is of special interest since these animals exhibit a wide range of reproductive adaptations. The protracted survival and viability of inseminated spermatozoa in the female genital tract of several species of bats inhabiting cold and temperate climates (Rollinat and Trouessart 1895-1897, Guthrie 1933, Matthews 1937, Wimsatt 1942, 1944) and the occurrence of delayed implantation (Mutere 1967, Gopalakrishna and Ramakrishna 1977) and the retarded development of the blastocyst (Ramakrishna and Rao 1977, Richardson 1977) in some of the tropical and sub-tropical bats are some of the interesting adaptations which these animals have evolved. Although all these phenomena have been noticed in the bats, most of the studies relate only to the females, whereas the reproductive habits and associated phenomena in the male bats have received very little attention, and even the few observations, which have been made on the males, have also been made only with a view to confirming the occurrence of reproductive adaptations in the females (Courrier 1927, Pearson *et al.* 1952). Among the more than one hundred species of bats reported from India some details regarding the reproductive habits of the males are available with regard to a single species of insectivorous bat, *Scotophilus temmincki*, reported about 35 years ago by Gopalakrishna (1948, 1949). A casual reference to the protracted viability of the spermatozoa stored in the epididymis of *Hipposideros speoris* has been made by Gopalakrishna and Bhatia (1983) while studying the sex-cycle of this species. The present study on the reproductive habits of the males of *Cynopterus sphinx* (Vahl) in Central India has been undertaken not only because there is so little known about the details of the male sex-cycle of bats and specially of the tropical species, but a preliminary study (Sandhu 1982) revealed that this species exhibits two distinct reproductive cycles during the year unlike all other bats so far studied except *Rousettus leschenaulti* (Gopalakrishna and Choudhari 1977). Ramakrishna

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(1947) indicated the occurrence of post-partum oestrus in *Cynopterus sphinx sphinx* at Bangalore. Most other tropical bats have either a single cycle in the year coinciding with the cycle in the female (Baker and Baker 1936, Baker and Bird 1936, Gopalakrishna 1947, 1949, Ramaswamy 1961, Madhavan 1971) or they are sexually active throughout the year (Wimsatt and Trapido 1952, Gopalakrishna 1954, 1955). The present work is also the first detailed study on the male reproductive cycle of a megachiropteran bat.

MATERIAL AND METHODS

This report is based on the examination of the gonads and accessory reproductive structures of 279 male specimens of *Cynopterus sphinx* (Vahl) collected at random at Nagpur at frequent intervals during two consecutive years commencing from 24th January, 1982 such that every calendar month is represented by several collections. The specimens were shot with an air rifle from their roosts amidst the bunches of old hanging fronds of palm trees. Each animal was weighed with the help of a sensitive spring balance and dissected immediately. The reproductive organs and accessory reproductive structures were removed and fixed in various fixatives. The tissues were sectioned at a thickness of 7 to 8 μ after passing through graded ethanol and embedding in paraffin. The sections were stained with Harris' or Ehrlich's haematoxylin and counterstained with eosin and mounted in DPX after clearing in xylol.

OBSERVATIONS AND DISCUSSION

A. *Breeding seasons*

Figure 1 is a scatter diagram giving the weight of the right testis of the specimens collected on different dates in the year, and the curve represents the changes in the weight of the testis of adult animals during different months of the year. Microscopic examination of the testis revealed that the intensity of spermatogenetic activity was directly related to the weight of the testis. These facts indicate that in Central India the males of *Cynopterus sphinx* experience two peak seasons of spermatogenetic activity, one during September-October and the second during January-February. After the first peak of spermatogenesis the weight of the testis drops rapidly, and there is nearly complete cessation of spermatogenesis during November and December after which the testis again increases in weight rapidly during January and reaches peak values during February when there is a sudden spurt of spermatogenesis. After February there is a rapid fall in the weight of the testis reaching low values during June and July when there is no spermatogenesis and the testis has a typical regressed cytology. Since the testis is nearly completely regressed during December, the two periods of spermatogenesis in the testis should be considered as two distinct sexual seasons rather than a continuous reproductive season commencing with September and ending in the following March with a decrease in spermatogenetic activity during November and December.

Figure 2 is a scatter diagram showing the relationship between the testis weight and the body weight. The dotted lines indicate the body weight and the testis weight at sexual maturity. From the graph it is evident that the weight of the regressed adult testis falls lower than that of the testis of immature animals which are probably approaching their first sexual season.

The annual changes in the weight of the epididymis is illustrated in figure 3 from which it is evident that the epididymis also has two peaks in its weight in the year, one during

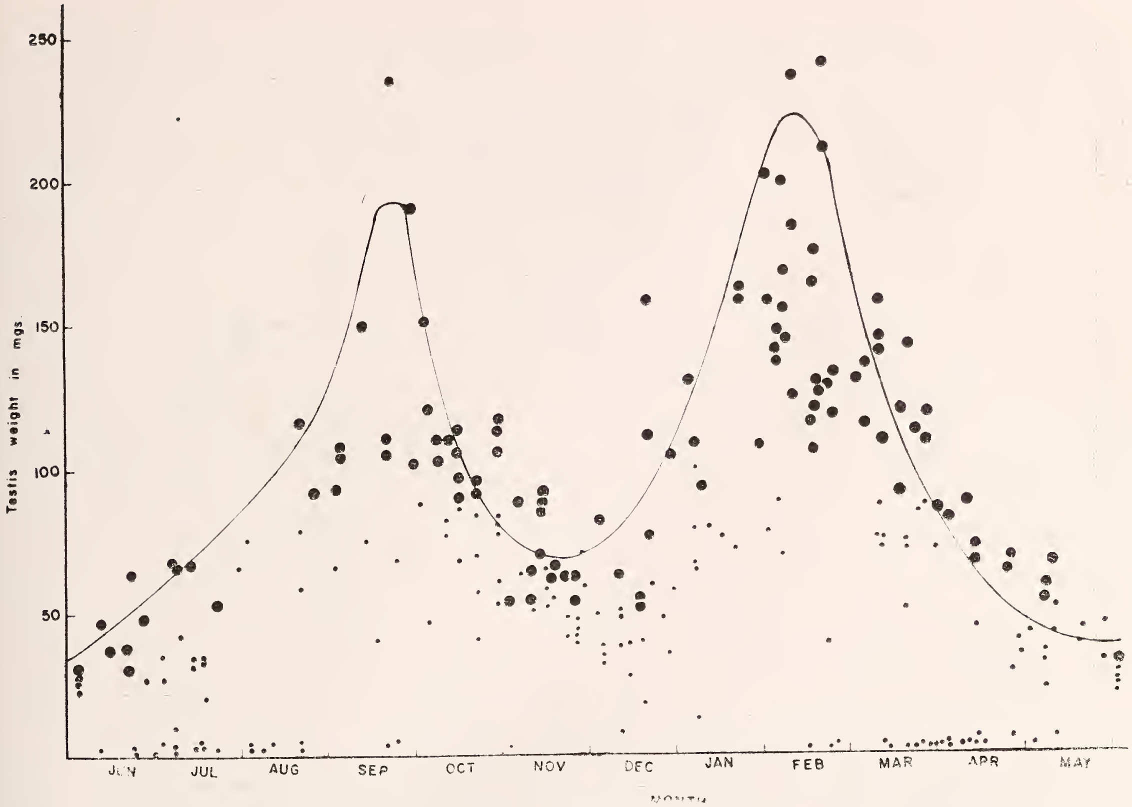

Fig. 1. Scatter diagram of the weight of the right testis of the animals plotted against the dates of collection during the different months of the year. Note two distinct peaks in the weight of the testis representing the two peaks of sexual activity. The doted line represents the lowest weight of the adult testis exhibiting active spermatogenesis.
(The heavy dots represent adult animals and the smaller dots sexually immature animals).

September-October and the second between January and March. These peaks nearly correspond to the peaks in testis weight, although the dip between the two peaks in the weight of the epididymis is not so well marked as that in the weight of the testis. Microscopic examination of the epididymis revealed that, while the epididymis was full of spermatozoa during September-October and between January and March, there is a sparse population of residual spermatozoa during December and they are totally absent from April to the beginning of September. From the above it is evident that although there is a cessation of spermatogenesis during November and December a few spermatozoa produced during September-October remain in the epididymis during November and December. This is also revealed by the graph (fig. 3) in which the first curve is considerably wider than the second thereby indicating that residual spermatozoa remain in the epididymis even after cessation of spermatogenetic activity in the testis.

The changes in the size and histology of the

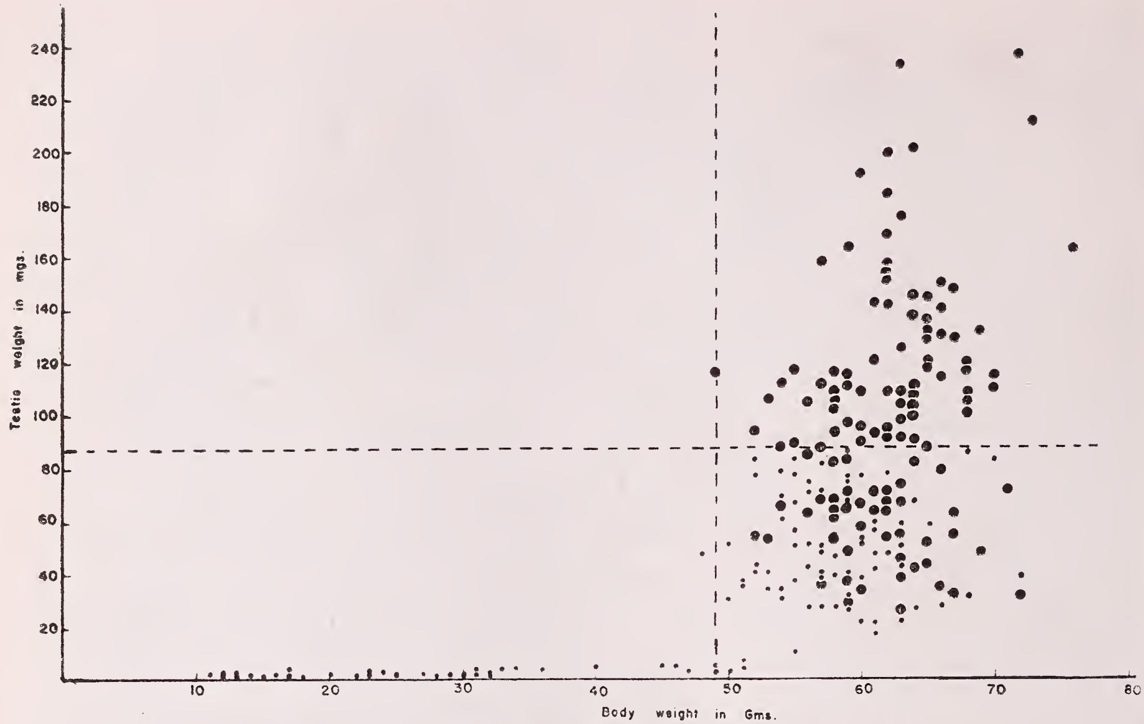

Fig. 2. Scatter diagram in which the weight of the right testis is plotted against the body weight of the corresponding animal. The dotted lines represent the lowest testis weight and the lowest weight at sexual maturity. Note that some of the inactive testes of the adults weigh less than the testes of some of the immature animals. (The heavy dots represent adult animals and the smaller dots sexually immature animals).

accessory reproductive organs in the male such as the seminal vesicles, prostate and Cowper's glands run closely parallel to those in the testis and the epididymis and these are similar to those in all other seasonally breeding mammals. These facts suggest that the males of *Cynopterus sphinx* in Central India have two distinct sexual seasons, one during September-October punctuated by a short interval of sexual quiescence during November-December and a second during January-February followed by a long period of sexual quiescence until the following September. The two periods of sexual activity in the male run closely parallel to the sexual habits of the females which experience two pregnancies in quick succession, the first pregnancy commencing in October-November with deliveries taking place during the following February-March and the second pregnancy following within a short period after parturition (Sandhu 1982).

It is evident from the foregoing account that *Cynopterus* exhibits a combination of the autumn breeding pattern of the bats inhabiting cold climates and the spring breeding habits of most of the tropical bats. *Rousettus leschenaulti* (Gopalakrishna and Choudhari 1977) is the only other bat which exhibits a similar feature. This fact, taken along with the fact that the female experiences two pregnan-

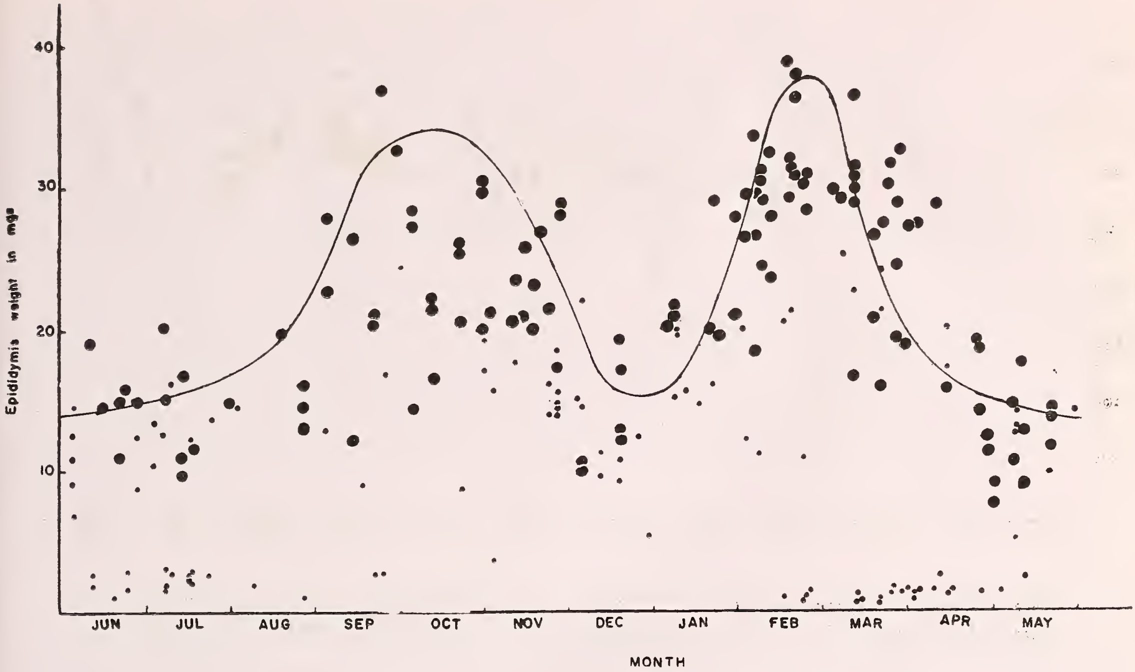

Fig. 3. Scatter diagram of the weight of the right epididymis plotted against the date of collection of the animal during different months of the year. The curve represents the two periods of peak values in the weight of the epididymis during the year. (The heavy dots represent adult animals and the smaller dots sexually immature animals).

cies in quick succession makes these two species unique among Chiroptera in regard to breeding biology.

B. *Growth and maturity*

In a previous paper it was shown that the deliveries of young ones occur twice in the year, once during February and March and the second time during June and July and that a single young one is delivered by each mother during each cycle (Sandhu 1984). Barring one exceptional specimen, which weighed 49 gm (collected on 18th February, 1982), whereas there was no sexually mature specimen with a body weight of less than 52 gm, not all specimens weighing above 52 gm were sexually mature. There were some males weighing as much as 71 gm but in which the testis presented a typically immature histology. Evidently, in these animals the body weight cannot be employed as the criterion for determining sexual maturity or otherwise in this species. However, the weight of the testis during the active breeding season is a good index of sexual maturity or otherwise in these animals. During September-October and during January-March the lowest weight of the testis exhibiting spermatogenesis was 87 mg and all the specimens with a testis weight of 87 mg and above exhibited vigorous spermatogenesis. On the basis of this criterion one could notice during the sexual season in September-October three distinct groups of animals: (1) those with a testis weight less than 10 mg — this group evidently consists

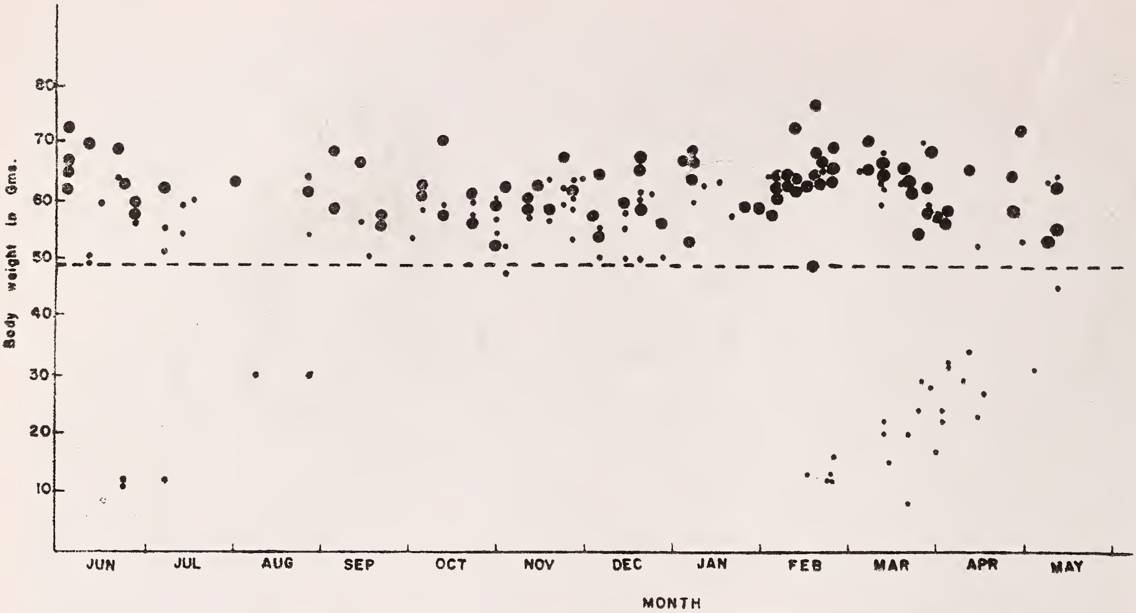

Fig. 4. Scatter diagram of the body weights of the male specimens plotted against the date of collection of the animals. The dotted line represents the lowest body weight at sexual maturity.
(The heavy dots represent adult animals and the smaller dots sexually immature animals).

of specimens born during the previous June-July, (2) specimens with testis weights between 39 and 56 mgs — this group would have been born during the previous February-March in which case they are about 7 to 8 months of age, and (3) specimens with testis weight of 87 mg and above — these animals would have been born either in June-July of the previous calendar year (that is, they are about 15 to 16 months of age) or during February-March of the previous year (that is, 19 to 20 months of age).

The specimens collected during the sexually active period during January-March also could be classified into three categories apart from those born during February-March of the same year and are mostly sucking animals: (1) animals with a testis weight of 37 mg and less — these are evidently the specimens born during June-July of the previous calendar year, (2) specimens with a testis weight between 64 and 78 mg — these would have been born during February-March of the previous calendar year and, hence, would be 12 to 13 months of age, and (3) specimens whose testis weighed 87 mg and more — there are fully sexually mature and would not have been born later than June-July two calendar years before, so that they are at least 19 to 20 months of age before reaching sexual maturity.

From the foregoing analysis it is evident that the specimens born in June-July come to sexual activity during September-October of the following calendar year, that is, when they reach an age of 15 to 16 months. On the other hand, animals born in February-March come to their first sexual activity during September-October of the following calendar year when they are 19 to 20 months of age. This difference in the age for attaining sexual maturity between the two groups of animals born during the two seasons of parturition is due to the fact that when the specimens born in February-March attain an age of 15 to 16 months the breeding season would not have commenced, and hence, they would have to wait another 3 or 4 months to experience their first sexual cycle with the onset of the breeding season during September-October.

Figure 4 is a scatter diagram of the body weight of the male specimens of this species collected on different dates. From this figure it is evident that adult and immature specimens occur throughout the year. Further, after attaining a certain body weight the sexually immature specimens cannot be distinguished from the mature ones on the basis of the body weight. Many immature specimens weigh as much as or even more than mature specimens.

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NEW DESCRIPTIONS

FIVE NEW SPECIES OF *TENTHREDO* LINNAEUS (HYMENOPTERA: TENTHREDINIDAE) FROM THE GARHWAL HILLS[1]

DEVINDER SINGH AND MALKIAT S. SAINI[2]

(*With twenty-one text-figures*)

Five new species of *Tenthredo* are reported from Garhwal hills, viz. *T. variolata, T. pseudofrontatus, T. acupunctata, T. serrulata* and *T. gopeshwari.* Apart from illustrating the genitalia, the new species have been separated from already reported related taxa. The population variation, if any, has also been discussed.

INTRODUCTION

Malaise's (1945) paper gives an exhaustive study of the taxonomy of Indian *Tenthredo* and includes a compilation of almost all the earlier works for southeast Asia, and has 18 new species of this genus from India. Muche's (1982, 1983) are the only works after Malaise (1945), which make an addition of 3 new species to that known earlier bringing the total number of species so far described from this country to 82. In the present study, which is one of the series of papers dealing with new records of *Tenthredo* from India, five new species are reported from the Garhwal hills (Uttar Pradesh). So far, this area has remained unexplored for sawflies.

The terminology used by Ross (1937, 1945) and Malaise (1945) has been followed.

The holotypes and paratypes are presently with the collection of the authors and will be submitted to IARI, Pusa National Collection, New Delhi (India), after this paper is published.

Tenthredo variolata sp. nov.

(Figs. 1, 6, 11, 14, 17)

FEMALE: Average length 11.5 mm. Body black except lateral side of mandible; broad medial spot on clypeus; small anterolateral spot on pronotum and broad hind margin of metepisternum; yellowish white. Siennous are: broad dorsal angle of pronotum; propodeum except narrow basal margin; broad apical margin of abdominal segment 5; medial spot along posterior margins of terga 8 and 9. Following are yellowish brown: tegula; front side of distal 3/4 of profemur and tibia; pro- and mesotarsi except infuscated tips of joints. Wings light brownish hyaline, fore one with distinctly infuscated oblique stripe from apex almost to base, costa and stigma reddish brown, venation light brown to fuscous.

Antenna strongly incrassate before apex, 1.3× head width, segments 3 and 4 in ratio 9:4; clypeus (Fig. 1) roundly emarginate upto 1/7 of its medial length with truncate lateral teeth; labrum subpentagonal, broader than long in ratio 4:3 with roundly pointed anterior margin; malar space equal to diameter of lateral ocellus; LID : IDMO : EL = 2.0:3.4:2.5;

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OOL : POL : OCL = 2.6:1.0:1.8; frontal area slightly above level of eyes; supra-antennal tubercle indistinct and confluent with similar frontal ridge; median fovea shallow with faint longitudinal carina; circum-, inter- and postocellar and lateral furrows fine and clear; postocellar area almost flat, broader than long in ratio 3:2; head slightly narrowing behind eyes; ITD : ICD = 2.6:1.0; mesoscutellum gibbose; appendage carinate: mesepisternum roundly and strongly raised; mesosternum lacking thorns; apical tooth of claw (Fig. 6) indistinctly longer than subapical; metabasitarsus as long as following 3 joints combined; metafemur distinctly shorter than tibia.

Head covered with large, deep and almost confluent punctures of irregular size, hind orbit minutely punctured with scattered large punctures; mesonotum and scutellum punctured like face above; appendage with few large punctures; metanotum minutely and distinctly punctured; metascutellum impunctate; mesepisternum with large, deep, pit-like and isolated punctures along with smaller ones on intervening spaces; mesosternum finely punctured; propodeum polished, remaining terga microsculptured.

Lancet (Fig. 17) broadened in middle with 20 serrulae, each serrula is triangular having 2-5 anterior and 8-10 distinct posterior subbasal teeth.

MALE: Length, 7.5 mm. Similar to female except: labrum with whitish basal spot; mesofemur having sordid white distal spot on front side. Penis valve (Fig. 11) and gonoforceps (Fig. 14).

Abbreviations (in text)

EL — eye length; ICD — intercencheri distance; IDMO — interocular distance at level of median ocellus; ITD — intertegular distance; LID — lower interocular distance; OCL — Oculo-occipital line; OOL — oculo-ocellar line; POL-postocellar line.

Material examined: Holotype, Female, Uttar Pradesh, Mandal—2300 m, 10.6.1983.

Paratypes: 10 ♀ ♀, 1 ♂, with same data as holotype.

Remarks: This species shows some resemblance to *T. odynerina* (Malaise, 1934). However, it can be separated from the latter by the black scape, siennous stripe along posterior margins of terga 1, 5, 8 and 9 and flat postocellar area with fine lateral furrow.

In *T. odynerina* the scape is pale, terga 1, 4 and 7-9 have pale stripe along posterior margins and postocellar area is subconvex with deep lateral furrow.

Etymology: The species name pertains to punctures of head and thorax which are deep pit-like, resembling marks of small pox.

Tenthredo pseudofrontatus sp. nov.
(Figs. 2, 7, 12, 15, 18)

FEMALE: Average length, 10.7 mm. Body black, whitish are: lateral side of mandible; large basal spot on labrum; broad lateral spots confluent in middle on clypeus; triangular spot on lower hind orbit touching eye; dorsal angle and spot along posterior margin of pronotum; tegula except medial spot; ridges lateral to meso- and metascutelli; anterolateral spot on appendage; spot on metepisternum; lateral side and narrow hind margin of propodeum; anterolateral deflexed margin of tergum 4; spots on lateral margins of terga 7 and 8 and posterior margins of corresponding sterna; front side of proleg except base of coxa, tips of meso- and metacoxae, meso- and metatrochanters, mesofemur and tip of tibia. Black of abdomen with bluish tinge. Forewing having distinctly infuscated cross band over stigma, its base clear while apex subinfuscated beyond stigma, hindwing clear, stigma and venation dark brown to black.

Antenna stout, distinctly compressed, 2.5×

head width, segments 3 and 4 in ratio 10:9; clypeus (Fig. 2) arcuately incised upto 1/4 of its medial length; labrum broader than long in ratio 5:4 with narrowly rounded anterior margin; malar space 0.7× diameter of lateral ocellus; LID:IDMO:EL = 2.0:3.6:3.5; OOL:POL:OCL = 2.6:1.0:2.3; frontal area below level of eyes; supra-antennal tubercle raised and confluent with similar frontal ridge; median fovea shallow; circumocellar furrow clear, interocellar furrow very deep, postocellar one inconspicuous; lateral furrow narrow and deep; postocellar area subconvex with faint longitudinal carina, broader than long in ratio 5:4; head narrowing behind eyes; ITD:ICD = 2.9:1.0; mesoscutellum slightly raised; appendage faintly carinate; mesepisternum obtusely raised with short and blunt carina at apex; mesosternum faintly angled without thorns; apical tooth of claw (Fig. 7) slightly shorter than subapical; metabasitarsus shorter than following 3 joints combined; metafemur slightly longer than tibia.

Head shining having minute and scattered punctures, frontal area with distinct punctures, hind orbit minutely and densely punctured; mesonotum polished; mesoscutellum with widely separated distinct punctures on posterior slope only; appendage, metanotum and scutellum impunctate; mesepisternum minutely punctured with deep and large punctures along convexity; mesosternum distinctly punctured; abdomen shining with few minute and scattered punctures.

Lancet (Fig. 18) with 26 serrulae, each serrula is deep having 2-3 irregular anterior and 5-6 lobe-like posterior subbasal teeth.

MALE: Average length, 8.1 mm. Similar to female except: clypeus and labrum totally whitish; appendage without white spot; metafemur with dirty white stripe on underside of basal half; all sterna with whitish hind margin; crossband of forewing less distinct. Penis valve (Fig. 12) and gonoforceps (Fig. 15).

Material examined: Holotype, Female, Uttar Pradesh, Mandal—2000 m, 15.6.1985.

Paratypes: 4 ♀♀, 3 ♂♂, with same data as holotype.

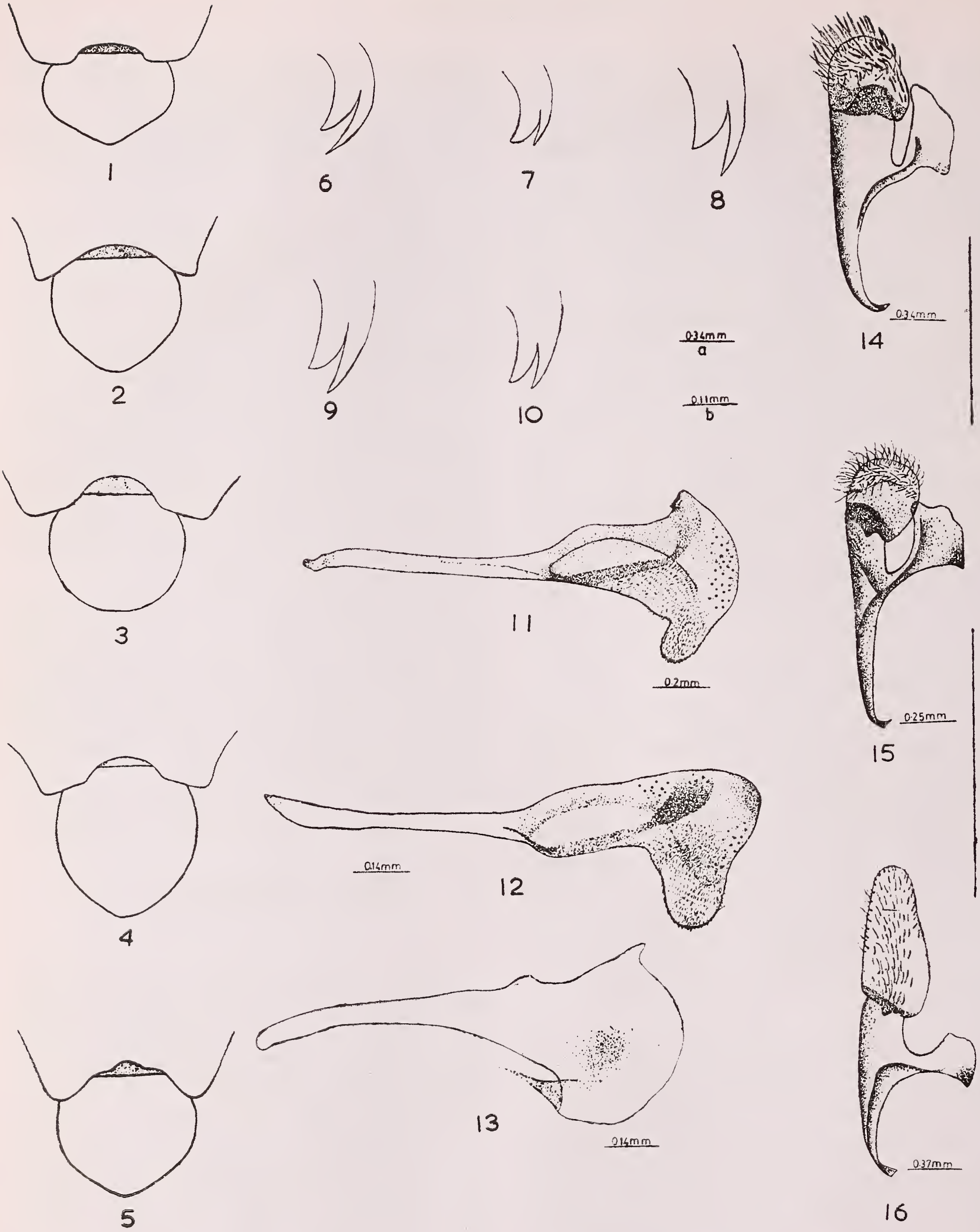
Remarks: This species belongs to a small group of two species having forewing with distinctly infuscated crossband over stigma and shows remarkable similarity to *T. frontatus* Malaise, 1945. However, it can be differentiated from the latter on account of the apex of the forewing infuscated beyond stigma, antenna 2.5× head width with segment 3 longer than 4, mesonotum and scutellar appendage polished, mesepisternum minutely punctured with deep and scattered punctures along convexity and lancet with 24 serrulae, each having 5-6 posterior subbasal teeth.

In *T. frontatus* apex of forewing is clear beyond stigma, antenna is 3.2 × head width with segment 3 shorter than 4, mesonotum is distinctly punctured and scutellar appendage wrinkled, mesepisternum is rugose along convexity and lancet has 31 serrulae, each having 2-4 posterior subbasal teeth.

Etymology: The species name pertains to its remarkable similarity with *T. frontatus*.

Tenthredo acupunctata sp. nov.
(Figs. 3, 8, 13, 16, 19)

FEMALE: Average length 11.9 mm. Body pale yellow, black are: tip of antennal segment 6 and 7-9 entirely; mandible tip; frontal spot anteriorly covering basal half of supra-antennal tubercle, laterally not extending beyond lateral fovea and posteriorly reaching up to anterolateral corner of postocellar area; spot outer to supraantennal tubercle continuous with frontal spot; broad stripe along anterior margin of pronotum; anterior margin of mesonotal middle lobe and broad spot on lateral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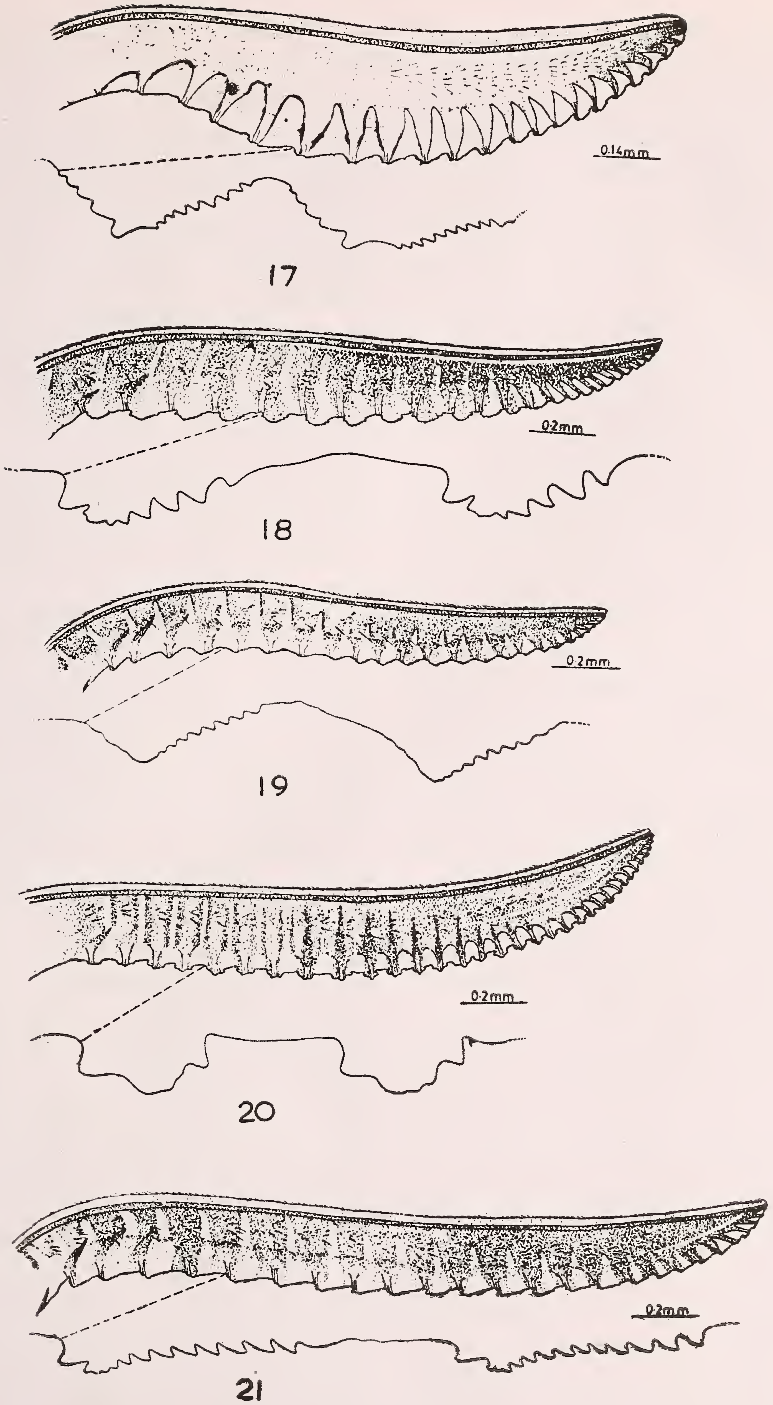
Figs. 1-16. Clypeus — 1. *T. variolata,* 2. *T. pseudofrontatus,* 3. *T. acupunctata,* 4. *T. serrulata,* 5. *T. gopeshwari*; Tarsal Claw — 6. *T. variolata,* 7. *T. pseudofrontatus,* 8. *T. acupunctata,* 9. *T. serrulata,* 10. *T. gopeshwari*; Penis Valve — 11. *T. variolata,* 12. *T. pseudofrontatus,* 13. *T. acupunctata*; Gonoforceps — 14. *T. variolata,* 15. *T. pseudofrontatus,* 16. *T. acupunctata.*
Figs. 1-5 at magnification *a*
Figs. 6-10 at magnification *b*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Figs. 17-21. Lancet — 17. *T. variolata,* 18. *T. pseudofrontatus,* 19. *T. acupunctata,* 20. *T. serrulata,* 21. *T. gopeshwari.*

lobe; visible part of mesopostnotum; spot on metanotum lateral to scutellum; irregular hind margin of metapostnotum; stripes along dorsal margin of mesepimeron and anterior margin of episternum; band along anterior border of mesosternum extending over its boundary with pleuron; large spot on metepisternum; proximal angle of mesocoxa and outer stripe on metacoxa; stripe along distal 2/3 of pro- and mesofemora posteriorly; basal spot on metafemur; metatibia except both ends. Abdomen having infuscated lateral spots along posterior borders of terga 2-6. Wings hyaline, costa and stigma yellowish, venation brown to black.

Antenna faintly compressed towards apex, 3.4 × head width, segment 3 indistinctly shorter than 4; clypeus (Fig. 3) roundly, narrowly incised upto 2/7 of its medial length with truncate lateral teeth; labrum indistinctly broader than long with rounded anterior margin; malar space equal to diameter of lateral ocellus; LID: IDMO:EL = 2.0:2.3:3.3; OOL: POL: OCL = 3.9:1.0:2.8; frontal area below level of eyes; supraantennal tubercle distinctly raised, sloping back and confluent with low frontal ridge; median fovea deep and distinct in anterior half only; circum- and postocellar furrows indistinct, interocellar one clear; lateral furrow deep; postocellar area slightly raised, broader than long in ratio 5:4; head narrowing behind eyes; ITD:ICD = 3.3:1.0; mesoscutellum roundly raised; appendage faintly carinate; mesepisternum obtusely raised without carina or acute apex; mesosternum without thorns; apical tooth of claw (Fig. 8) slightly longer than subapical; metabasitarsus as long as following 3 joints combined; metafemur slightly shorter than tibia.

Head, mesonotum and scutellum subshining, minutely, shallowly and densely punctured; appendage with few large and shallow punctures; metanotum and scutellum shallowly punctured; mesepisternum finely punctured with sebaceous lustre; mesosternum densely punctured and faintly microsculptured; abdomen microsculptured.

Lancet (Fig. 19) with 24 serrulae, each serrula is somewhat pointed having no anterior and about 9 posterior subbasal teeth.

MALE: Average length, 9.5 mm. Similar to female except: antennal segments 1-3 and basal half of 4 with black outer stripe; pro- and mesotibiae and tarsi striped with black posteriorly; basal 1/2 of metafemur black from upperside; first and last tarsal joints of metaleg, black. Penis valve (Fig. 13) and gonoforceps (Fig. 16).

Material examined: Holotype, Female, Uttar Pradesh, Chopta — 3000 m, 16.6.1985.

Paratypes: 3 ♀ ♀, 3 ♂ ♂, with same data as holotype.

Population variation: Metatibia only faintly infuscated in middle; abdomen without infuscated spots.

Remarks: Applying Malaise's (1945) key, this new species shows some similarity to *T. lissuana* Malaise, 1945 and *T. tibetana* Malaise, 1945. However, it can be distinguished from both on account of having the tip of antennal segment 6 and 7-9 entirely black, abdomen pale, at the most with small infuscated spots on terga 2-6, supraantennal tubercle and frontal ridge confluent, mesepisternum roundly raised without carina, head minutely and shallowly punctured and mesepisternum minutely punctured.

In *T. lissuana* the antenna is entirely pale, each abdominal tergum has large black spot, mesepisternum is flat with strong curved carina and head is coarsely punctured.

In *T. tibetana* the supra-antennal tubercle and frontal ridge are separated by broad furrow, the head is smooth and shining and mesepisternum is rugose along convexity.

Etymology: The species name pertains to fine and superficial punctures of body.

Tenthredo serrulata sp. nov.
(Figs. 4, 9, 20)

FEMALE: Length, 13.7 mm. Body pale to reddish yellow, black are: antenna except underside of scape; mandible tip; frontal spot anteriorly covering median fovea leaving tip of supraantennal tubercle, extending laterally without reaching eye and posteriorly touching hypothetical hind margin of head; postocellar area; most of posterior side of head; transverse medial stripe without reaching lateral margin and small spot at dorsal angle of pronotum; mesonotum except triangular apex of middle lobe and minute spot outer to mesoscutellum on lateral lobe; visible part of mesopostnotum; metanotum except spot on deflexed part; hind margin of metapostnotum; very narrow stripe along each pleural suture; propodeum except deflexed side and triangular medial spot along hind margin; narrow basal margin of tergum 2, interrupted in middle; metatibia except distal end. Apex of abdomen on dorsal side from tergum 6, tips of tibiae and tarsal joints, reddish brown. Wings yellowish hyaline, fore one infumated towards apex, stigma reddish yellow, venation dark brown to black.

Antenna stout, faintly compressed towards apex, 2.0× head width, segments 3 and 4 in ratio 3:2; clypeus (Fig. 4) roundly and narrowly incised upto 1/6 of its medial length with truncate lateral teeth; labrum indistinctly longer than broad with rounded anterior margin; malar space 1.6× diameter of lateral ocellus; LID : IDMO : EL = 2.0 : 3.1 : 2.6; OOL : POL : OCL = 3.7 : 1.0 : 3.1; frontal area slightly below level of eyes; supraantennal tubercle distinctly raised and confluent with similar frontal ridge; median fovea narrow and deep with distinct pit in middle; circum-, inter- and postocellar furrows distinct; lateral furrow sunken; postocellar area convex with faint indication of longitudinal carina, as long as broad; head slightly dilated behind eyes; ITD: ICD = 2.9:1.0; mesoscutellum subpyramidal; appendage bluntly carinate; mesepisternum obtusely raised with apex compressed and truncate; mesosternum slightly cornered but without thorns; apical tooth of claw (Fig. 9) longer than subapical; metabasitarsus shorter than following 3 joints combined; metafemur as long as tibia.

Head shining with minute and scattered punctures on hind orbit; mesonotum and anterior slope of scutellum polished; posterior slope of mesoscutellum and appendage with few minute punctures; metanotum and scutellum impunctate; mesepisternum with minute and indistinct punctures along with sebaceous lustre; mesosternum distinctly punctured; abdomen faintly microstriated and minutely punctured.

Lancet (Fig. 20) with 33 serrulae, each serrula is deep having single lobe-like anterior and 3-4 irregular posterior subbasal teeth.

MALE: Unknown.

Material examined: Holotype, Female, Uttar Pradesh, Chopta — 3000 m, 25.6.1985.

Paratype: No.

Remarks: This species shows close similarity to a Burmese species *T. flavobrunneus* Malaise, 1945. However, it can be differentiated from the latter by the frontal spot not touching eyes, postocellar area entirely black, costa black and appendage with some distinct punctures.

In *T. flavobrunneus* the frontal spot is connected with eye, hind margin of postocellar area is pale, costa is reddish yellow and appendage is polished.

Etymology: The species name pertains to characteristic shape of serrulae.

Tenthredo gopeshwari sp. nov.
(Figs. 5, 10, 21)

FEMALE: Average length, 13.2 mm. Body

reddish yellow with following black: tip of antennal segment 1, 2-5 entirely and immediate base of 6; mandible tip; spot near anterior margin of mesonotal middle lobe and large spot on lateral lobe; spot lateral to cenchrus; lateral spot on metapostnotum; large spot on metepimeron; metepisternum; dim anteromedial and lateral spots on propodeum; terga 6-9 except deflexed sides; sawsheath. Pale yellow are: antennal segment 6 except base, 7-9 entirely; face below antenna; narrow inner and lower hind orbits; posterolateral spot on pronotum; triangular apex of mesonotal middle lobe; mesoscutellum. Tips of all tarsal joints faintly infumated. Wings yellowish hyaline, apex of fore one distinctly infuscated upto distal end of stigma, hindwing faintly infumated towards apex, costa and stigma fulvous with infuscated spot on latter, venation dark brown to black.

Antenna filiform, 2.8× head width, segments 3 and 4 in ratio 10:11; clypeus (Fig. 5) roundly incised upto 2/7 of its medial length with irregular anterior margin; labrum broader than long in ratio 4:3 with rounded anterior margin; malar space equal to diameter of lateral ocellus; LID:IDMO:EL = 2.0:3.3:3.0; OOL: POL: OCL = 3.4:1.0:2.4; frontal area below level of eyes; supraantennal tubercle distinctly raised and confluent with similar frontal ridge; median fovea narrow with longitudinal carina in anterior half; circum-, inter- and postocellar furrows sharp; lateral furrow fine and deep, diverging posteriorly; postocellar area slightly raised with faint longitudinal carina, broader than long in ratio 5:4; head narrowing behind eyes; ITD: ICD = 3.8:1.0; mesoscutellum roundly raised; appendage faintly carinate; mesepisternum roundly raised; mesosternum lacking thorns; apical tooth of claw (Fig. 10) slightly shorter than subapical; metabasitarsus longer than following 3, but shorter than all remaining joints combined; metafemur as long as tibia.

Head and mesonotum polished; mesoscutellum with a few distinct punctures on posterior slope only; appendage faintly wrinkled; metanotum and scutellum impunctate; mesepisternum with sebaceous lustre having shallow and scattered punctures; mesosternum distinctly punctulate; propodeum polished, remaining terga minutely and finely punctured.

Lancet (Fig. 21) with 25 serrulae, each serrula is almost flat having 1-2 anterior and about 11 posterior subbasal teeth.

MALE: Unknown.

Material examined: Holotype, Female, Uttar Pradesh, Mandal — 2300 m, 16.6.1985.

Paratypes: 4 ♀♀, with same data as holotype.

Population variation: Tergum 5 completely black.

Remarks: In the peculiar colour of the antenna this species does not show relationship with any other species. However, it shows a distant similarity to *T. purpureipennis* Malaise, 1945 but can be easily separated from the latter on account of having black antenna with pale yellow apical segments, supra-antennal tubercle and frontal ridge confluent and apical tooth of claw shorter than subapical. In *T. purpureipennis* the antenna is black with basal 3 segments reddish, supra-antennal tubercle is separated from frontal ridge and apical tooth of claw is longer than subapical.

Etymology: The species name has been taken from the city situated near its type locality.

ACKNOWLEDGEMENTS

We are grateful to Dr. D. R. Smith of Systematic Entomology Laboratory c/o USNM, for his helpful suggestions. The financial assistance rendered by ICAR and DST, New Delhi, for the research projects under which this work has been completed, is gratefully acknowledged.

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A NEW SPECIES OF *STICTOPISTHUS* THOMSON (HYMENOPTERA: ICHNEUMONIDAE) FROM INDIA[1]

L. J. KANHEKAR[2] AND P. K. NIKAM[3]

(*With four text-figures*)

Stictopisthus carinata sp. nov. is described and a key to the Indo-Australian species of *Stictopisthus* is provided.

INTRODUCTION

Stictopisthus Thomson (Hymenoptera: Ichneumonidae: Mesochorinae) is a moderate sized genus with worldwide distribution. Species of this genus are secondary parasitoids of lepidopterous larvae and hyperparasitoids of species of *Euphorus* Nees and *Cotesia* (= *Apanteles*) Cameron (Braconidae). Townes *et al.* (1961) recorded seven species from Indo-Australian region, namely *Stictopisthus australiensis* Szépligeti from Australia, *S. javensis* Ferriére from Java, *S. guamensis* Townes from Micronesia and *Mesochorus hapaliae* Rao, *M. panti* Rao, *M. plusiaephilus* Viereck, and *M. srinaraini* Gupta from India. Townes (1971) provided generic diagnosis, pictorial key and distribution of this genus. In the present study a new species, *Stictopisthus carinata* is described based on the material collected from Aurangabad, Maharashtra, India and a key to the Indo-Australian species of *Stictopisthus* Thomson is provided.

The Types are with the authors for the time being and will be deposited in National collection of the Zoological Survey of India, Calcutta.

Stictopisthus carinata sp. nov.

FEMALE: 6.20 mm in length. *Head* (Figs. 2-3): 0.80 as long as broad, above 2× as broad as thick; vertex weakly, sparsely punctate; ocellar triangle moderately raised, sparsely punctate; ocello-ocular distance 2× their diameter; frons finely mat, above antennal

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socket grooved, smooth, with paired, submedian vertical weak carinae from median ocellus to inner side of antennal sockets; face and clypeus forming a broad surface; face sparsely punctate, 0.85 as long as broad, baso-medially weakly elevated, latrad to elevation weakly depressed, apico-lateral corners obliquely, finely striate, upper margin with a transverse carina that is straight across the mid line, laterally weakly oblique above; clypeus apico-medially subshiny, not separated by distinct groove, clypeal fovae moderate; mandible moderately elongate, weakly striato-punctate, teeth equal; cheek as long as the basal width of mandible, striate; maxillary palpi long, enough to reach the centre of mesosternum; temple sparsely punctate; occiput shiny; occipital carina complete; genal carina joining to the oral carina above the base of mandible.

Antenna: Equal to the body length; 2+33 segmented; first flagellar segment 1.10× as long as the length of scape and pedicel combined, 1.45× as long as the second segment; terminal segment 2.50× as long as broad.

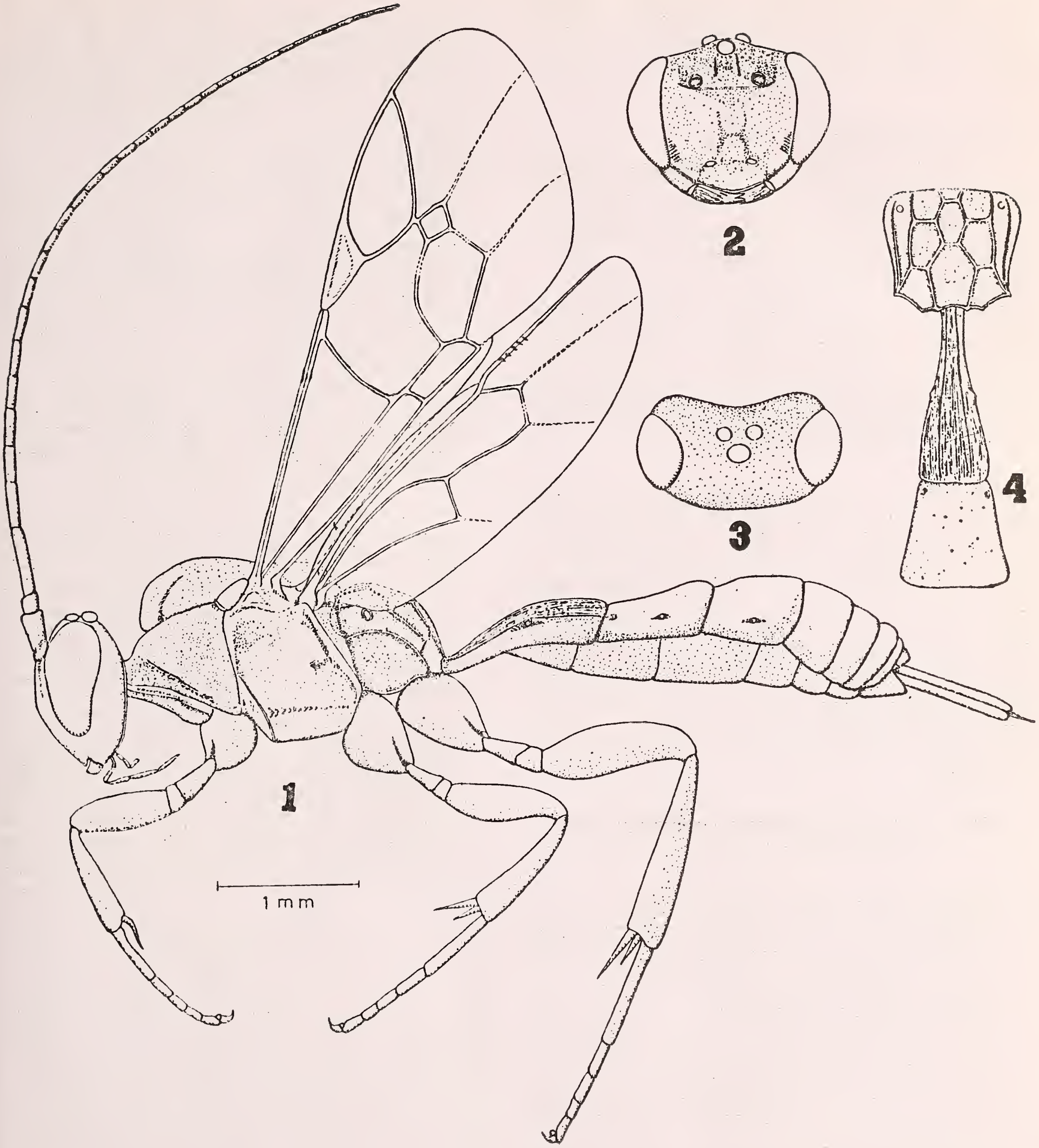
Thorax: 2.15× as long as broad; collar subshiny, coarsely punctate, pronotum finely, sparsely punctate, with deep oblique groove behind collar, epomia weak; mesoscutum convex, medially moderately and laterally finely punctate, notaulii distinct; scutellum convex, as long as broad, finely, sparsely punctate, lateral carinae restricted to base; postscutellum small, shiny; propleurum subshiny, sparsely punctate; mesopleurum dorso-anteriorly densely punctate, medially subshiny, with sparse, minute punctures, rest sparsely punctate, prepectal carina extending below the midheight of mesopleurum, its upper end joining to front of mesopleurum, postpectal carina incomplete, sternaulus anteriorly strongly impressed, posteriorly weak, mesopleural impression in the form of a pit, joining mesepimeron by weak groove, speculum smooth; metapleurum finely, sparsely punctate; propodeum (Fig. 4) evenly convex, finely, sparsely punctate, areola elongate, 1.45× as long as broad, emitting costulae at middle, propodeal spiracles large, circular; hind femur 3.20× as long as broad, basitarsus 0.95 as long as the length of rest tarsus, claw weakly curved, simple.

Fore wings: 4.20 mm in length, 1.55 mm in width; stigma 2.80× as long as broad, not hyaline; basal abscissa of radius 0.50 the length of its apical abscissa; areolet broadly petiolate, 0.80 as high as wide, receiving second recurrent near its middle; second recurrent 0.50 the length of basal abscissa of subdiscoideus, apically fenestrated, slightly inclivous; discocubitus strongly arched; basal vein moderately arched; nervulus distad by 0.75 its length, vertical; basal abscissa of postnervulus as long as its apical abscissa; second discoidal cell 2× as long as broad; discocubital cell 1.55× as long as broad.

Hind wings: 3.20 mm in length, 0.95 mm in width; with 1+4-5 hamuli; basal abscissa of radiella 0.25 the length of its apical abscissa; latter with basal stub, rest in the form of a trace; mediella strongly arched; basal abscissa of cubitella as long as its apical abscissa, latter in the form of a trace; discoidella absent; nervellus straight, reclivous; brachiella traceable.

Abdomen: 1.20× as long as the length of head and thorax combined; first tergite (Fig. 4) 2.50× as long as broad, with dorsolateral and ventrolateral carinae, dorsally longitudinally, closely acciculate, laterally subshiny, spiracles at 0.50, glymma present; rest of the tergites subshiny; thyridium present at the base of second tergite; ovipositor sheath 7.25× as long as wide, 0.50 as long as the length of hind tibia; ovipositor long, straight.

Coloration: Pale-brown. Ocellar triangle, first lateral area of propodeum blackish-brown; mandibular teeth, ovipositor sheath, wing veins



Figs. 1-4. *Stictopisthus carinata* sp. nov. ♀
1. Adult; 2. Head, frontal aspect; 3. Head, view from above; 4. Propodeum with first and second tergites.

and stigma reddish-brown; hind tibia basally and apically, first tergite medially, second tergite latero-basally, third tergite apically black.

MALE: Unknown.

Holotype: ♀ INDIA: MAHARASHTRA, Aurangabad, Cantonment, 5.viii.1982, on wing, coll. L. J. Kanhekar. Antenna and wings mounted on slides and labelled as above.

Paratypes: 2♀♀, INDIA: MAHARASHTRA, Aurangabad, Himayat Bagh, 1♀, 30.xi.1982, on wing, coll. L. J. Kanhekar; 1♀ reared from prepupae of *Charops obtusa obtusa* Morley, 10.x.1975, coll. K. S. Heble.

Comments: *Stictopisthus carinata*, sp. nov. resembles *S. panti* Rao and *S. srinaraini* Gupta but readily differs from the former in having: ocello-ocular distance 3 × the inter-ocellar distance, frons mat, face punctate, distally all veins of fore wings joining to apical margin, first tergite acciculate, spiracles at 0.50 and second tergite longer than broad; however it differs from the latter in the characters shown in the key.

KEY TO THE INDO-AUSTRALIAN SPECIES OF *Stictopisthus* THOMSON

1. Areola basally open, long and narrow.
Micronesia .... *guamensis* Townes, 1958
— Areola basally close, short and wide 2
2. Nervulus interstitial or basal to basal vein 3
— Nervulus distal to basal vein 4
3. Propodeum blackish above; areola narrower at base than apex; abdominal petiole as long as postpetiole; mandibular teeth brown. India .... *plusiaephilus* Viereck, 1913
— Propodeum brownish or black; areola broader at base than apex; abdominal petiole longer than postpetiole; mandibular teeth black. Java .... *javensis* Ferriére, 1925
4. Ovipositor as long as second abdominal tergite. Antenna 20 segmented; occiput wrinkled; second abdominal tergite broader than long. Australia .... *australiensis* Szépligeti, 1914
— Ovipositor longer than second abdominal tergite 5
5. Antennae shorter than the body; face rugulose, shiny; mesoscutum smooth and shiny; notauli indistinct. India .... *hapaliae* Rao, 1953
— Antennae longer than or as long as the body; face punctate or smooth; mesoscutum punctate; notauli distinct except in *srinaraini* Gupta 6
6. Ocello-ocular distance 1.35× the inter-ocellar distance; face smooth; basal abscissa of radius 0.30 the length of its apical abscissa. India .... *panti* Rao, 1953
— Ocello-ocular distance 2-3× the inter-ocellar distance; face punctate; basal abscissa of radius 0.45-0.50 the length of its apical abscissa 7
7. Vertex smooth; antennae 28 segmented; first flagellar segment 1.55× as long as second segment; scutellum shiny; propodeum smooth; postnervulus intercepted above the middle; apical abscissa of cubitella and brachiella without any trace; first tergite with a small knob-like elevation in the middle of its apical margin.
India .... *srinaraini* Gupta, 1957
— Vertex sparsely punctate; antennae 35 segmented; first flagellar segment 1.45× as long as second segment; scutellum sparsely punctate; propodeum sparsely punctate; postnervulus intercepted at middle; apical abscissa of cubitella and brachiella weakly traceable; first tergite without any knob-like elevation. India .... *carinata*, sp. nov.

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A NEW GALL-MIDGE OF THE GENUS *LESTODIPLOSIS* KIEFFER (DIPTERA: CECIDOMYIIDAE) FROM MAHARASHTRA, INDIA[1]

R. M. SHARMA[2]

(*With seven text-figures*)

A new gall-midge species *Lestodiplosis brevilobata,* collected at light in Aurangabad, Maharashtra, India has been illustrated and described with a key to Indian species.

Lestodiplosis brevilobata sp. nov.
(Figs. 1-7)

MALE: Body 1.16 mm long. Eyes confluent above. Trophi slightly produced. *Palpus*: quadriarticulate, moderately long, light-straw, sparsely setose; first segment (10:6) short, cylindrical, length 1.66 × its maximum thickness; second segment (16:7) cylindrical, length a little less than 2.30× its maximum thickness; third segment (15:6) cylindrical, narrowed basally, shorter and thinner than second, length 2.50× its maximum thickness, fourth segment (20:5) cylindrical, longest of all, slightly thinner than third, narrower at base than at apex, length 4.00× its maximum thickness. *Antenna*: longer than body, with 2 + 12 segments, flagellate segments binodose, with long apical stems, enlargements with two whorls of long setae, one on each enlargement, with three whorls of long, regular circumfilla, one on basal and two on apical enlargements, basal and apical whorls of subequal length, middle whorl shortest, circumfila loops nearly as long as the diameter of the apical enlargements; scape (23:25) cup-shaped, wider than long; pedicel (13:17) sub-globose, wider than long; third segment (62) confluent with and longer than fourth, with a very small basal prolongation (2:4), basal enlargement (15:16) 0.24 the length of the segment and slightly broader than long, basal stem (10:6) 0.66 the length of the basal enlargement and 1.66× its maximum thickness, apical enlargement (21:17) longer than basal, 0.33 the length of the segment and 1.23× its maximum thickness, apical stem (13:7) shorter than apical

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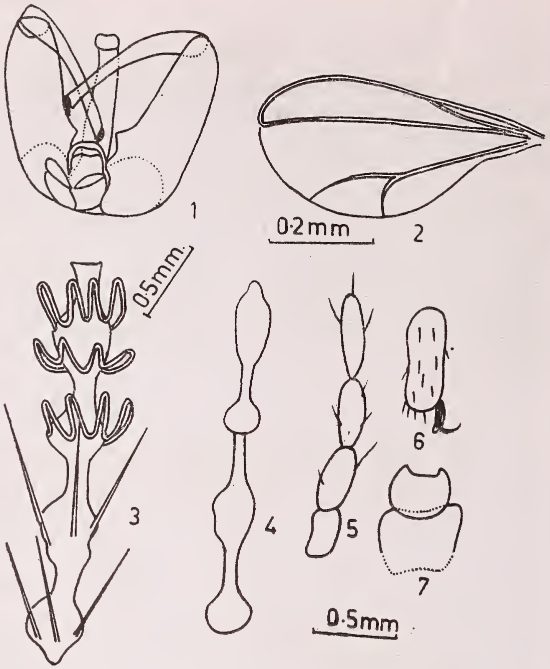
enlargement, length a little less than 2.00× its maximum thickness, fourth segment (60) with basal enlargement (14:18) 0.23 the length of the segment and broader than long, basal stem (10:6) 0.71 the length of the basal enlargement and 1.66× its maximum thickness: apical enlargement (20:17) longer than basal, 0.33 the length of the segment and 1.17× its maximum thickness, apical stem (16:7) shorter than apical enlargement, length 2.28× its maximum thickness; fifth segment similar and as long as fourth; sixth to tenth segments nearly similar to each other but shorter than fifth (58); eleventh and twelfth segments similar but shorter than tenth (57); penultimate segment (56) shorter than twelfth, basal enlargement (9:13) 0.16 the length of the segment and 1.44× as broad as long, basal stem (14:4) 1.55× longer than basal enlargement and 3.50× as long as thick; apical enlargement (17:12) 0.30 the length of the segment, slightly less than twice the length of the basal enlargement and 1.41× its maximum thickness, apical stem (15:4) shorter than apical enlargement, length 3.75× its maximum thickness; terminal segment (46) shortest of all, basal enlargement (9:12) a little less than 0.20 the length of the segment and 1.33× as broad as long, basal stem (13:4) 1.44× longer than basal enlargement, slightly more than 3.00× as long as thick, apical enlargement (20:10) 0.40 the length of the segment, more than twice the length of the basal enlargement and 2.00× as long as thick, apical stem in the form of an apical nipple-like prolongation (4:3). *Wing*: (65:30) hyaline, neither too long nor too broad, 2.16× as long as broad, vein *Rs* absent, vein *R5* reaching wing margin beyond apex and interrupting costa at its union, vein *Cu* forked. *Legs*: long, hairy, metatarsus (8) as long as terminal tarsal segment (8), second tarsal segment (36) longest of all and longer than the following segments combined together (31); claw evenly curved, sickle-shaped, simple on all legs; empodium (10:10) narrow, as long as claw. *Genitalia*: brown, sparsely setose, basal clasp segment (58:23) cylindrical with a very small tiny triangular, setose, basal lobe, length slightly more than 2.50× its maximum thickness; terminal clasp segment (45:6) slender, gradually tapering towards the tip and ending in a pointed tooth, 0.77 the length of the basal clasp segment and 7.50× as long as thick; dorsal plate cup-shaped, bilobed, margins of the lobes setose, subdorsal plate entire, longer than dorsal plate, flattened with sclerotized extreme apex, setose; aedeagus (55:9) cylindrical, shorter than basal clasp segment broad



Figs. 1-7. *Lestodiplosis brevilobata*, sp. nov. ♂ 1. Genitalia (dorsal view); 2. wing; 3. third and fourth antennal segments; 4. penultimate and terminal antennal segments; 5. palpus; 6. claw; 7. scape and pedicel.

medially, length 6.11 × its maximum thickness, tip shallowly notched in the middle.

FEMALE: Unknown.

Holotype: Male dissected and mounted on slide labelled "at light, at Harsul Power Station, Aurangabad, Maharashtra, India, R. M. Sharma, Coll., dated 28.viii.1976." Type slides are deposited in the collections of Z.S.I., Pune for the present.

Paratypes: Four males dissected and mounted on slides, labelled as in Holotype.

Etymology: The specific epithet refers to a very small basal lobe of basal clasp segment.

This species resembles closely *L. lunata* Grover and Bakshi as shown in the Key.

KEY TO INDIAN SPECIES OF *Lestodiplosis* KIEFFER

1. Palpi triarticulate .... *jonesi* (Nayar) 1949
— Palpi quadriarticulate 2
2. Wings spotted .... *triangularis* Grover & Bakshi 1977-78
— Wings not spotted 3
3. Circumfila loops regular 4
— Circumfila loops irregular, dorsal plate bilobed with basal spines, subdorsal plate elliptically linear .... *heterofila* (Grover) 1965
4. Basal clasp segment with prominent basal lobe 5
— Basal clasp segment with a tiny or with no prominent basal lobe 7
5. Lobe of basal clasp segment setose 6
— Lobe of basal clasp segment asetose, subdorsal plate emarginate apically .... *emarginata* Sharma & Rao 1979
6. Lobe of basal clasp segment long and auriculate, subdorsal plate entire, rounded apically .... *auriculata* Grover 1979
— Lobe of basal clasp segment short and elongated, subdorsal plate short and compressed .. .. *erecta* (Nayar) 1949
7. Basal clasp segment without prominent basal lobe, dorsal plate bilobed, lobes rounded apically, subdorsal plate linear, broad, arched apically .... *lunata* Grover & Bakshi 1977-78
— Basal clasp segment with a tiny triangulalr basal lobe, dorsal plate bilobed, lobes flattened apically, subdorsal plate entire, rounded apically .... *brevilobata* sp. nov.

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A NEW GENUS OF CHALCIDIDAE (HYMENOPTERA: CHALCIDOIDEA) FROM THE COLLECTIONS OF UNITED STATES NATIONAL MUSEUM OF NATURAL HISTORY, WASHINGTON, D.C.[1]

T. C. Narendran[2]

(*With nine text-figures*)

A new genus *Grisselliella* from Panama is described with a new species, *Grisselliella panamensis*.

During my study-stay at the United States National Museum of Natural History, Washington, D.C. (hereafter USNM) in 1986, I examined several specimens of Chalcididae and found a remarkable genus from Panama which did not fit to any of the genera described or redescribed or listed by Kirby (1883), Spinola (1811), Ashmead (1904), Kieffer (1904), Schmiedeknecht (1909), Schmitz (1946), De Santis (1979, 1981), Burks (1940), Boucek (1951), Narendran (1984, 1986) or any other worker. This new genus is described below. I name this genus in honour of Dr. Edward Eric Grissell of Systematic Entomology Laboratory, USDA, c/o USNM for his significant contributions to the study of Chalcidoidea and for his help and valuable suggestions during my research at Washington, D.C.

Grisselliella gen. nov.

Diagnosis: This new genus belongs to the subfamily Chalcidinae and can be separated from all other genera of Chalcidinae in having the following characters: Frons with thick characteristic yellow pubescence on middle part of parascrobal space (Fig. 1); pronotum with two spine-like teeth on each side of anterior margin (Fig. 2); hind coxa spindle-shaped towards distal end (Fig. 7).

Type-species: *Grisselliella panamensis* sp. nov.

Grisselliella panamensis sp. nov.
(Figs. 1-9)

FEMALE: Length: 5.48-5.91 mm. Black with following parts otherwise: eyes yellow; pronotum yellowish red; all coxae, fore and mid femora and tibiae liver-brown; hind femur dark brown with pale yellow patches; all tarsi pale yellow; tegulae and sides of scapulae reddish yellow; first gastral tergite blackish brown; wings smoky; pubescence yellow.

Head width subequal to maximum width of thorax when measured from above; POL and OOL as in figure 2; head smooth and shiny with scattered minute pits and profuse long pubescence. Frons with characteristic yellow pubescence at middle parascrobal space (Fig. 1). Scrobe smooth and as in figure 1; area below scrobe swollen and convex; right mandible tridentate; left mandible bidentate; frontogenal suture distinct.

Thorax with peculiar characteristic two teeth on each side of anterior margin of pronotum as in figure 2. Punctures on thorax deep, notaulices deep and clear; apex of scutellum as in figure 5; thorax with scattered long, brownish yellow pubescence. Propodeum with deep pits as in figure 6. Hind coxa long and spindle-shaped as in figure 7, without tooth on ventral or dorsal side; hind femur prominently

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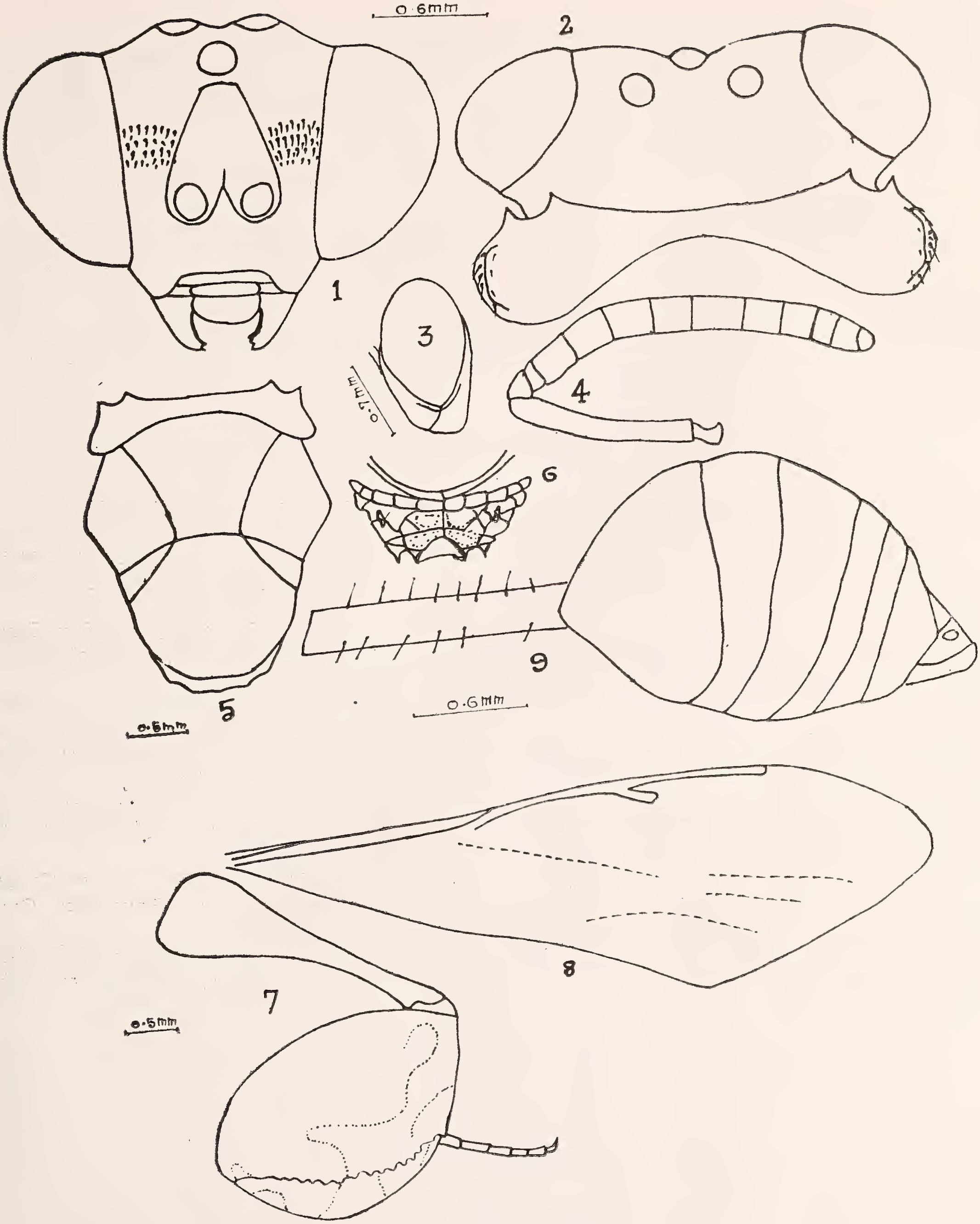
0·6mm
2
1
3
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6
5
0·6mm
9
0·6mm
8
7
0·5mm

Figs. 1-9. *Grisselliella panamensis* sp. nov.
1. Head, front view; 2. Vertex and pronotum; 3. Head profile; 4. Antenna; 5. Thorax dorsal view; 6. Propodeum; 7| Hind leg; 8. Forewing; 9. Gaster.

swollen, moderately pubescent, without an inner basal tooth, outer ventral margin with a row of irregular teeth; hind tibia with its apical spine fitting into a deep depression at inner side of hind femur. Forewing and venation as in figure 8.

Petiole smooth without carina on dorsal side, with a row of long hairs on either side; gaster (Fig. 9) with first to fifth tergites smooth, sparsely pubescent on sides of second to sixth tergites, sixth tergite with shallow faint pits.

MALE: Unknown.

Holotype: ♀, PANAMA: Concepcion, October 1959, N.L.H. Krauss (USNM); Paratype: ♀, same data as for holotype.

ACKNOWLEDGEMENTS

I am deeply indebted to Dr. E. E. Grissell of USNM for the help extended to me during my stay at Washington, D.C. I thank the authorities of USNM for giving me facilities to work at the Museum's laboratory.

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A NEW SPECIES OF *SECAMONE* (ASCLEPIADACEAE) FROM SOUTH ANDAMANS (INDIA)[1]

A. K. Goel[2] and M. K. Vasudeva Rao[3]

(*With a text-figure*)

The genus *Secamone* R. Br. is recorded for the Andaman and Nicobar Islands with a new species *S. andamanica* sp. nov. from South Andamans.

Introduction

During the course of explorations in South Andamans for the collection of plants for biological screening programme, a rare specimen of family Asclepiadaceae was collected. Study of the available literature and herbarium sheets indicates that it is an undescribed species belonging to the genus *Secamone* R. Br.

Secamone andamanica sp. nov. (Fig. 1)

Species distincta, a *S. emetica* (Retz.) R. Br. ex Schultes differt caulibus junioribus prope nodos brunneo-pilosis-glabrescentibus; corona staminali segmentis 5 incurvis subulatis liberis; antherae connectivo producto in appendice membranacea, subquadrata fimbriata. — Holotypus lectus a *A. K. Goel* sub numero 16604 A, ad locum Jolly Boys Island, South Andaman, die October 24, 1986, positi in herbario CDRI, Lucknow.

Secamone andamanica sp. nov. (Fig. 1)

A distinct species differing from the common coastal, rarely inland, scrub *Secamone emetica* (Retz.) R. Br. ex Schultes of Peninsular India and Sri Lanka in the following characters: Young stems near nodes glabrescent-brown hairy. Leaves broadly lanceolate, gradually acuminate. Staminal corona of 5, free, subulate, incurved segments; anther connective produced into a membranous, subquadrate, fimbriate appendage. — Holotype: *A. K. Goel* 16604 A- (CDRI), Jolly Boys Island, South Andamans.

Straggling laticiferous shrubs, 1.5-2.0 m tall. Stems brownish; upper branchlets green with swollen nodes, glabrescent-brown hairy on the axil and for some length on either side of nodes. Leaves opposite, lanceolate to ovate lanceolate; lamina 3.5-7.0 × 1.0-2.8 cm, thinly coriaceous, dark green on adaxial surface, glaucous green on abaxial surface, margin entire, sometimes distantly obscurely serrulate in anterior portion, 11-14 nerved; midrib and primary nerves sunken above, flattened below, nerves looped and joining below margins; base acute to cuneate; apex gradually acuminate; petioles 4.0-7.0 mm long, terete with narrow groove on upper surface with a few brown hairs at base. Inflorescence a dichasial cyme, shorter than leaves, 1.5-2.5 cm long, glabrescent-puberulous. Bracts 0.75-1.0 × 0.5 mm, triangular, yellowish green. Pedicels 3.0-5.0 mm long, puberulous. Flowers greenish yellow, 2.5-3.0 mm across; sepals 5 parted, imbricate, 1.0×0.75 mm, oval, puberulous outside, obtuse at apex, ciliolate at margins, without any gland inside at base. Corolla rotate, tube short, 0.5 × 0.9 mm, abruptly widened to lobes; corolla lobes 1.3-1.5 mm long, twisted to left in bud, later erect, oblong, obtuse, sometimes notched at apex with distinct

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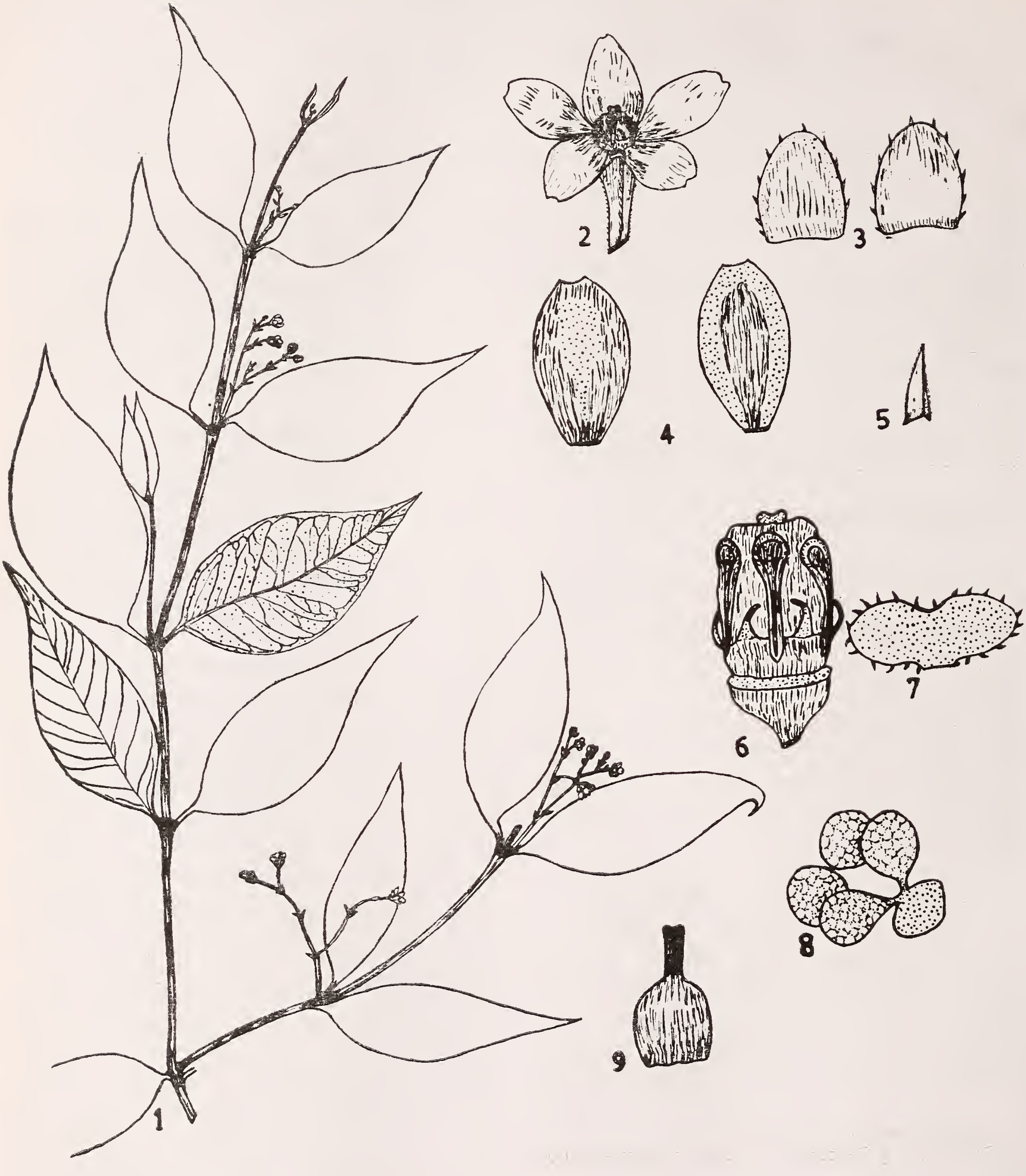

Fig. 1. *Secamone andamanica* sp. nov.
1. Habit; 2. Flower; 3. Sepal in dorsal and ventral view; 4. Petal in ventral and dorsal view; 5. Bract in side view; 6. Staminal column; 7. Anther appendage; 8. Pollinia with corpusculum; 9. Gynoecium. (*A. K. Goel* 16604).

concave groove flanked by thick calli at base on inner side. Staminal column *c.* 1.0 mm long, completely attached to the ovary; staminal corona of 5 lobes, very small, subulate, broader and attached just below the middle in between stamens, free, incurved above; anthers completely united, anther appendage subquadrate, fimbriate; pollinia 4, oval transparent, shining, attached to viscid somewhat oval corpusculum with 2 very small, thick filaments. Stigma exceeding the stamens, bilobed; style simple; ovary bicarpellate.

Habitat: Rare near sea shore amidst black boulders associated with *Colubrina asiatica.*

Flowering: September-October.

Distribution: INDIA: South Andamans.

Exsiccata: INDIA: South Andamans: Jolly Boys Island, October, 24, 1986; *A. K. Goel* 16604 A — Holotype (CDRI); *A. K. Goel* 16604 B — Isotype (PBL); *A. K. Goel* 16604 C, D, — Isotypes (CDRI).

ACKNOWLEDGEMENTS

We thank Dr. U. C. Bhattacharyya, Deputy Director, Central National Herbarium, Howrah for permission of herbarium consultation and Dr. N. C. Majumdar for the latin diagnosis.

BOTHRIOCHLOA PARAMESWARANII — A NEW SPECIES OF POACEAE FROM KERALA, INDIA[1]

P. V. SREEKUMAR, C. P. MALATHI AND V. J. NAIR[2]

(*With a text-figure*)

Bothriochloa parameswaranii sp. nov.
(Fig. 1)

Bothriochloa kuntzeana (Hack.) Henr. affinis, sed culmis brevioribus (usque ad 30 cm), gracilibus; foliis brevioribus, angustioribus (usque ad 3 mm latis); nodis glabris; spiculis sessilibus, brevioribus (usque ad 4 mm); foveis spicularum pedicellarum 1-4, vadosis; antheris brevioribus (usque ad 1.25 mm), differt.

Perennials. Culms 10-30 cm high, erect or geniculate; nodes glabrous. Leaves lanceolate, 2-10 × 0.2-0.3 cm, base rounded, glabrous or shortly villous, midrib prominent. Ligules ovate, acute, 1-2 mm, membranous. Racemes 2-4, digitate or subdigitate, each 2-4 cm long, purplish; joints 2-3 mm long, linear, ciliate. Sessile spikelets oblong or elliptic, 3-4 mm long, callus bearded; lower glume oblong, 3-3.5 × 1-1.25 mm, acute or subacute, chartaceous, flat or with a shallow depression, faintly 7-9-nerved, keels pectinate towards apex, margins hyaline, ciliate; upper glume ovate-lanceolate, 3-3.5 × 1-1.5 mm, chartaceous, 3-5-nerved, villous in the upper half, margins hyaline; lower floret empty; upper floret bisexual; first lemma ovate-oblong, 2.5-3 × 1-1.25 mm, rounded at apex, delicate, hyaline, faintly 3-5-nerved; palea absent; second lemma stipitate, 1-2 mm long, awn 10-15 mm long, column 6-8 mm, chestnut-brown; palea absent; stamens 3, anthers 1-1.25 mm; ovary oblong, 0.5-0.75 mm, styles *c.* 1 mm long, stigmas 1-1.5 mm, feathery. Pedicelled spikelets oblong, lanceolate, 3-4 mm long; pedicels 2-3 mm long, villous; lower glume oblong-lanceolate, 3-4 × 1 mm, chartaceous, 11-15-nerved, with 1-4 shallow pits, keels shortly pectinate; upper glume and lower floret similar to those of sessile spikelet; upper floret male or empty;

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[1] Accepted May 1987.

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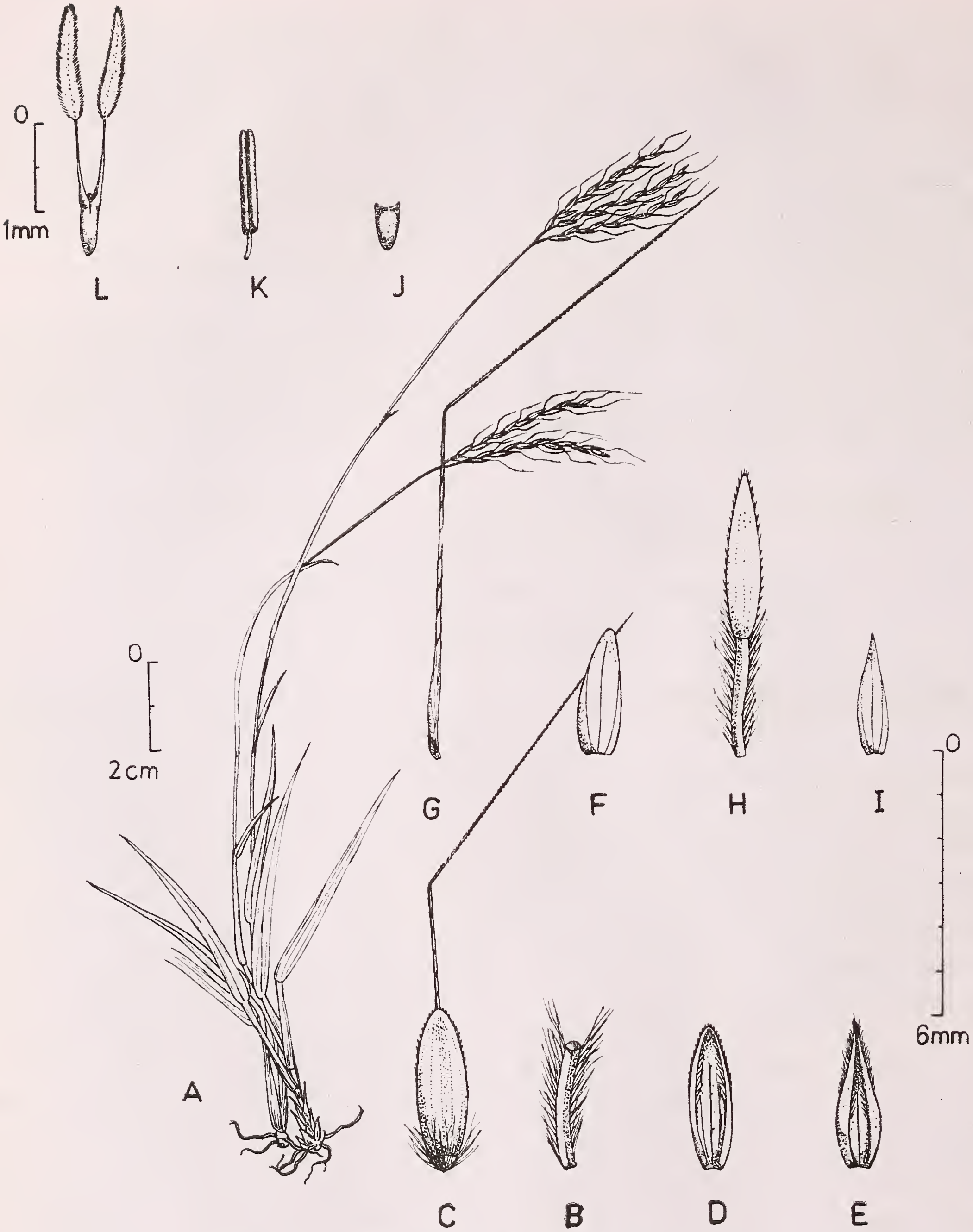

Fig. 1. A-L. *Bothriochloa parameswaranii* sp. nov.
A. Habit; B. Joint of raceme; C. Sessile spikelet; D. Lower glume of the sessile spikelet (ventral view); E. Upper glume of the sessile spikelet (ventral view); F. First lemma; G. Second lemma; H. Pedicelled spikelet; I. Second lemma of the pedicelled spikelet; J. Lodicule; K. Stamen; L. Pistil.

second lemma oblong-acute, 2-3 mm long, delicate, hyaline, faintly 3-nerved; lodicules 2, obovate, each *c.* 0.5 × 0.25 mm, concave at apex.

The specific epithet is in honour of Dr. M. Parameswaran Nayar, Director, Botanical Survey of India, for his outstanding contributions to Indian Botany.

	Bothriochloa kuntzeana	*Bothriochloa parameswaranii* sp. nov.
1.	Culms 40-80 cm tall, stout	Culms up to 30 cm tall, slender
2.	Leaf blades 30-50 cm long, 4-6 mm wide	Leaf blades up to 10 cm long, 2-3 mm wide
3.	Nodes densely bearded	Nodes entirely glabrous
4.	Sessile spikelets 4.5-5 mm long	Sessile spikelets smaller, up to 4 mm long
5.	Pit on the lower glume of the pedicelled spikelets solitary, deep	Pits on the lower glume of the pedicelled spikelets 1-4, shallow
6.	Anthers *c.* 2 mm long	Anthers 1-1.25 mm long

Holotype: KERALA, Idukki Dt: Eravikulam National Park, ± 2100 m, 14th February 1981, *P. V. Sreekumar* 71858 (CAL). Isotypes in K & MH.

Rare. Grasslands at higher elevations.

This species is allied to *Bothriochloa kuntzeana* but differs markedly from it as shown in the above table.

ACKNOWLEDGEMENTS

We thank Dr. T. A. Cope of the Royal Botanic Gardens, Kew, England for his valuable opinion on the specimens and Dr. N. P. Balakrishnan, Scientist SE, Botanical Survey of India, Coimbatore-3 for kindly going through the manuscript.

DESCRIPTION OF A NEW SPECIES OF THE GENUS *ALEUROLOBUS* QUAINTANCE & BAKER (1914) (ALEYRODIDAE: HOMOPTERA)[1]

B. V. DAVID,[2] R. W. ALEXANDER JESUDASAN[3] AND GEORGE MATHEW[4]

(*With three text-figures*)

The genus *Aleurolobus* Quaintance & Baker (1914) is represented in India by twenty six species (Alexander Jesudasan 1987). An aleyrodid species collected from *Gmelina arborea* was found to be distinct from the known species of *Aleurolobus* which is described in this paper.

Aleurolobus gmelinae sp. nov. (Figs. 1-3)

Pupal case: White with waxy secretion, oval. ♀ 0.825-0.875 mm long and 0.565-0.590 mm wide, ♂ 0.680-0.710 mm long and 0.425-0.440 mm wide, found severely infesting the undersurface of leaves.

Margin: Irregularly dentate, about 8-10 dentations in 0.1 mm; thoracic and caudal tracheal pores and combs wanting; paired anterior and posterior marginal setae evident, measuring 17.5-30 μ and 20-60 μ long, respectively.

Dorsal surface: Submargin with a row of paired wax secreting tubercles placed very close to the margin; width of submargin 60 μ. Longitudinal and transverse moulting sutures

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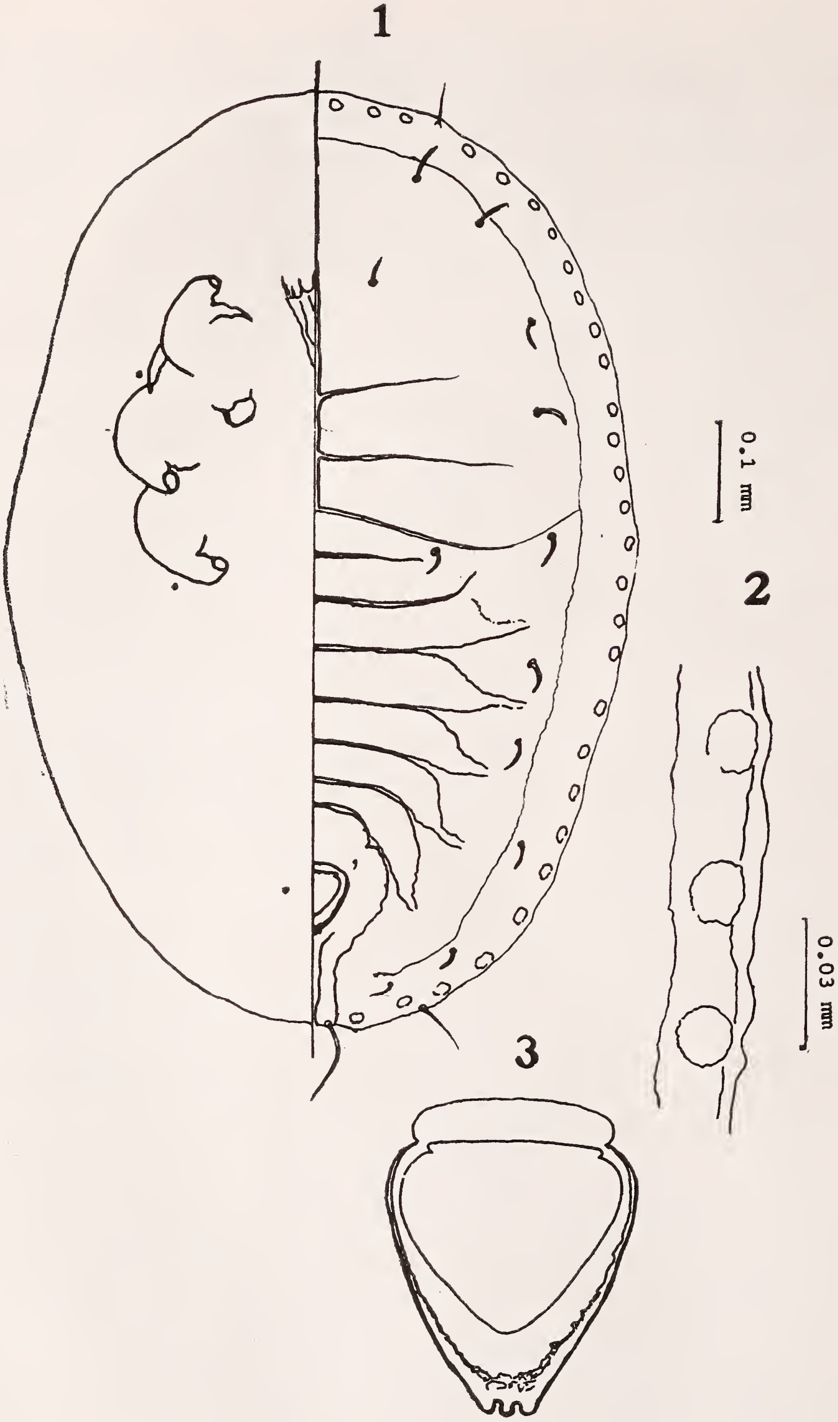

Figs. 1-3. 1. Pupal case of *Aleurolobus gmelinae* sp. nov.; 2. Margin and Submargin; 3. Vasiform orifice.

thin, the former not reaching the margin while the latter reaching submargin. Pro-meso and meso-metathoracic sutures distinct. Abdominal segment sutures 3-7 not reaching submargin. Paired dorsal setae evident: cephalic 22.5 μ, first abdominal of the same length, eighth abdominal 12.5 μ and caudal setae 75 μ long. The tips of the cephalic and first abdominal setae blunt while it is tapering in the eighth abdominal and caudal setae. Seven pairs of blunt subdorsal setae present, four on cephalothorax and three on the abdomen laterad of abdominal segments one, four and five, 21.25 μ long. Three pairs of submarginal setae laterad of abdominal segments six, seven and postero-laterad of eighth abdominal segment, 21.25 μ long.

Vasiform orifice triangular shaped, 70 μ long and 59.5 μ wide; operculum cordate shaped concealing lingula, wider than long, 42.5 μ long and 48.75 μ wide. Three tooth-like processes evident at base of vasiform orifice. Caudal furrow indicated.

Ventral surface: Thoracic and caudal tracheal folds not discernible; paired ventral abdominal setae 17.5 μ long and 47.5 μ apart. Antenna of male 120 μ long reaching mesothoracic legs while that of female 77.7 μ long. Mouth parts, spiracles and adhesive sacs distinct.

Material examined: *Holotype*: 1 ♀, *Gmelina arborea,* Peechi (Kerala State), 29.10.1986, Coll. George Mathew.

Paratype: 7 pupal cases (3 ♀♀, 4 ♂♂) on slides bearing same data as of holotype: 3 have been retained in the collections of B. V. David and the rest will be deposited in the collections of the Zoological Survey of India, Calcutta; Division of Entomology, Indian Agricultural Research Institute, New Delhi; Systematic Entomology Laboratory, USDA, Maryland, U.S.A.; and the British Museum (Natural History), London, U.K.

Pupal cases on dry leaves of *Gmelina arborea* in the collections of BVD.

This species resembles *Aleurolobus confusus* David & Subramaniam, 1976 in the colour and shape of the pupal case and also by the presence of blunt setae but differs from it in the shape of vasiform orifice and lingula not exposed and absence of thoracic and caudal tracheal folds.

Thanks are due to the ICAR for funding a scheme on the Taxonomy of Indian Aleyrodidae.

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A NEW SPECIES OF THE GESNERIACEAE FROM NAGALAND[1]

D. B. Deb and Ratna Dutta[2]

(*With a text-figure*)

An undescribed species of the Genus *Paraboea* of the family Gesneriaceae based on earlier misidentified specimen is described.

In course of taxonomic revision of the genus *Spiradiclis* (Rubiaceae) two misidentified specimens, one at CAL and the other at BSI were found, which are of actually hitherto undescribed species of the Genus *Paraboea* of the family Gesneriaceae, and are described here.

Paraboea nagalandiana sp. nov.

(Fig. 1)

Differt a *P. multiflora* (R. Br.) B. L. Burtt, foliis angusti-oblongi vel elliptico-lanceolatis, pedunculis solitaris, terminalis, racemoso-paniculis, sepalis angusto-lanceolatis staminodis duobus presaentibus und ovaris glabris, inter alia.

Allied to *P. multiflora* (R.Br.) Bl. Burtt differing in narrowly oblong or elliptic-lanceolate leaves, terminal solitary peduncle, racemose panicle, narrowly lanceolate sepals, presence of two staminodes and glabrous ovary amongst others.

Undershrubs 15-30 cm high, with straggling woody stem, rooting at the base, unbranched or dichotomously branching, more or less pubescent. *Leaves* opposite, decussate, petiolate, 5-17 × 2-5 cm, narrowly oblong or elliptic-lanceolate, acute or subacute at the apex, narrowed to or rounded and slightly unequal at the base, entire at margin, thin coriaceous, pale green above, brownish below, glabrescent above, arachnoid-tomentose on the midrib and nerves below; lateral nerves 6-12 pair, subopposite, oblique, subparallel inconspicuous towards the margin; petiole 5-15 mm long, pubescent. Inflorescence terminal, peduncled racemose panicle, 10-20 × 3.5 cm, pubescent, with a pair of foliaceous bracts at the base. *Flowers* bracteate, bracteolate, pedicelled, 3-4 mm long, pubescent; bracts solitary, ± 1-2 × 0.3 mm, lanceolate, acute, pubescent; bracteoles solitary, 0.5-1 × 0.2-0.3 mm, linear, acute, pubescent; pedicel 0.3-0.5 mm long, pubescent. *Calyx* lobed nearly to the base; lobes 5, unequal, 2-3 × 0.2-0.5 mm, narrowly lanceolate. *Corolla* campanulate; tube short, 0.8-1 mm long, glabrous inside; lobes 5, imbricate, nearly similar, 0.8-1.2 × 0.4-1 mm. *Stamens* epipetalous, alternate with petals, 2 perfect, 2 staminodes, attached near the base of the corolla tube, glabrous; filaments thick, alternating with the petals, 0.8-1 mm long; anthers large, with widely divergent lobes, 2-celled, 0.2-0.5 mm × 0.3 mm, globose or ellipsoid; pollen grains 3-zonocolporate, spheroidal 15-21 μm; exine 1.5 μm thick, surface granulate, granules less than 1 μm. *Staminodes* 2, filaments as long as in fertile stamens, anthers smaller. Disc absent. *Ovary* 0.8-1 mm long, ovate; ovules in parietal placenta; style as long as the ovary; stigma terminal, simple. *Capsule* immature ones included within calyx lobes, ± 2.5 ×1 mm, oblong, dehiscing along both the sutures. *Seeds* few, subglobose, ± 0.8 × 0.6 mm, smooth, reticulate.

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[1] Accepted June 1987.

[2] Central National Herbarium, Indian Botanic Garden, Howrah, India.

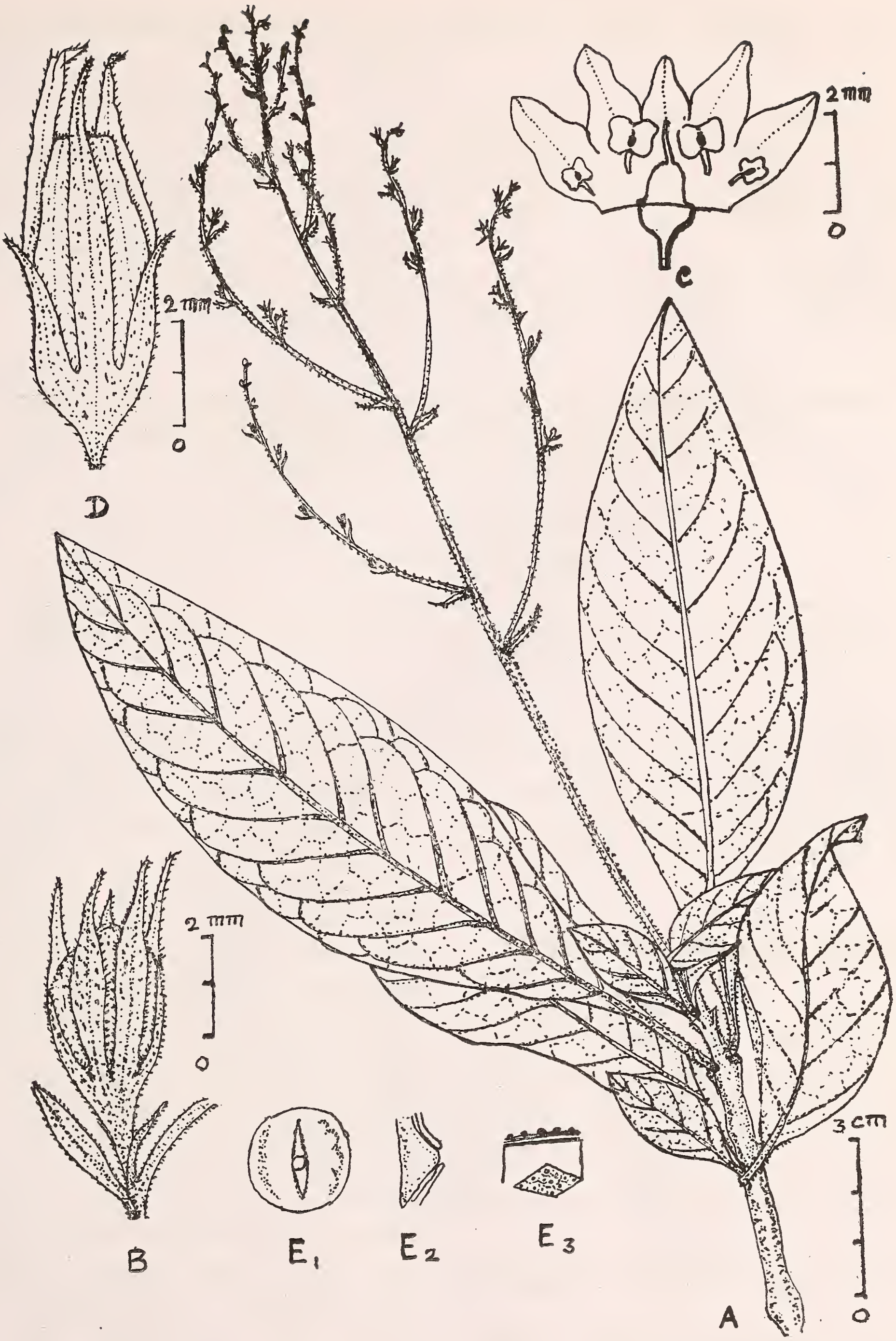
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Fig. 1. *Paraboea nagalandiana* sp. nov.
A. habit; B. flower in bud; C. floral parts; D. fruit (immature); E. pollen grain.

Flowering: December - January; *fruiting*: January —?

Type: Nagaland: Narum, 1200-1500 m (4000-5000 ft.), Dec. 1907, *A. Meebold* 7394 (holo. CAL); Sarpung, 1500 m? (5000 ft.), Dec. 1907, *A. Meebold* 7230 (para. BSI).

Note: As matured flowers and fruits are insufficient, opening of the flower and dehiscence of the fruit could not be described in detail.

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THREE NEW SPECIES OF THE GENUS *ACANTHASPIS* (AMY. AND SERV.) FROM SOUTHERN INDIA (HETEROPTERA — REDUVIIDAE — ACANTHASPIDINAE)[1]

DAVID LIVINGSTONE AND C. MURUGAN[2]

(*With three text-figures*)

Three new species of the genus *Acanthaspis* from the Oriental region, namely *Acanthaspis nigripes*. *Acanthaspis siruvanii*, and *Acanthaspis minutum* are described. All the three species have been illustrated.

The genus *Acanthaspis* of the subfamily Acanthaspidinae has the largest number of described species and the three new species described below add further to the wealth of the Reduviid fauna of the Oriental region.

Acanthaspis nigripes sp. nov. (Fig. 1)

MALE: length 21 mm, width across the abdomen 8 mm; micropterous; elongate; unicolorous, piceous except the distal half of the wing which is luteous; head elongately ovate; the frontal groove confluent with the transverse deep fissure in front of the ocellar prominence; second segment of the antenna almost double the length of first segment which is much shorter than the head; first rostral segment slightly longer than the second; eyes very prominently globose; ocelli purplish brown, much elevated; collar elongate, swollen posteriorly; thorax laterally and ventrally with dense hairs, dorsally with sparsely distributed hairs; pronotal anterior and posterior lobes almost equal in length, anterior lobe globose, dorsally marked by sulcations and carinations, both uniformly piceous; anterior border of the anterior lobe slightly concave, lateral margins with backwardly directed short tubercles; posterior margin of the posterior lobe on either side of the middle line transversely foveated up to the base of the posterolateral sharply pointed tubercular spine; scutellar spine elongate, sharply pointed upward, scutellum with well demarcated dorso-median foveation; posterior lobe of pronotum and scutellum rugulose; wing pad rudimentary, extending

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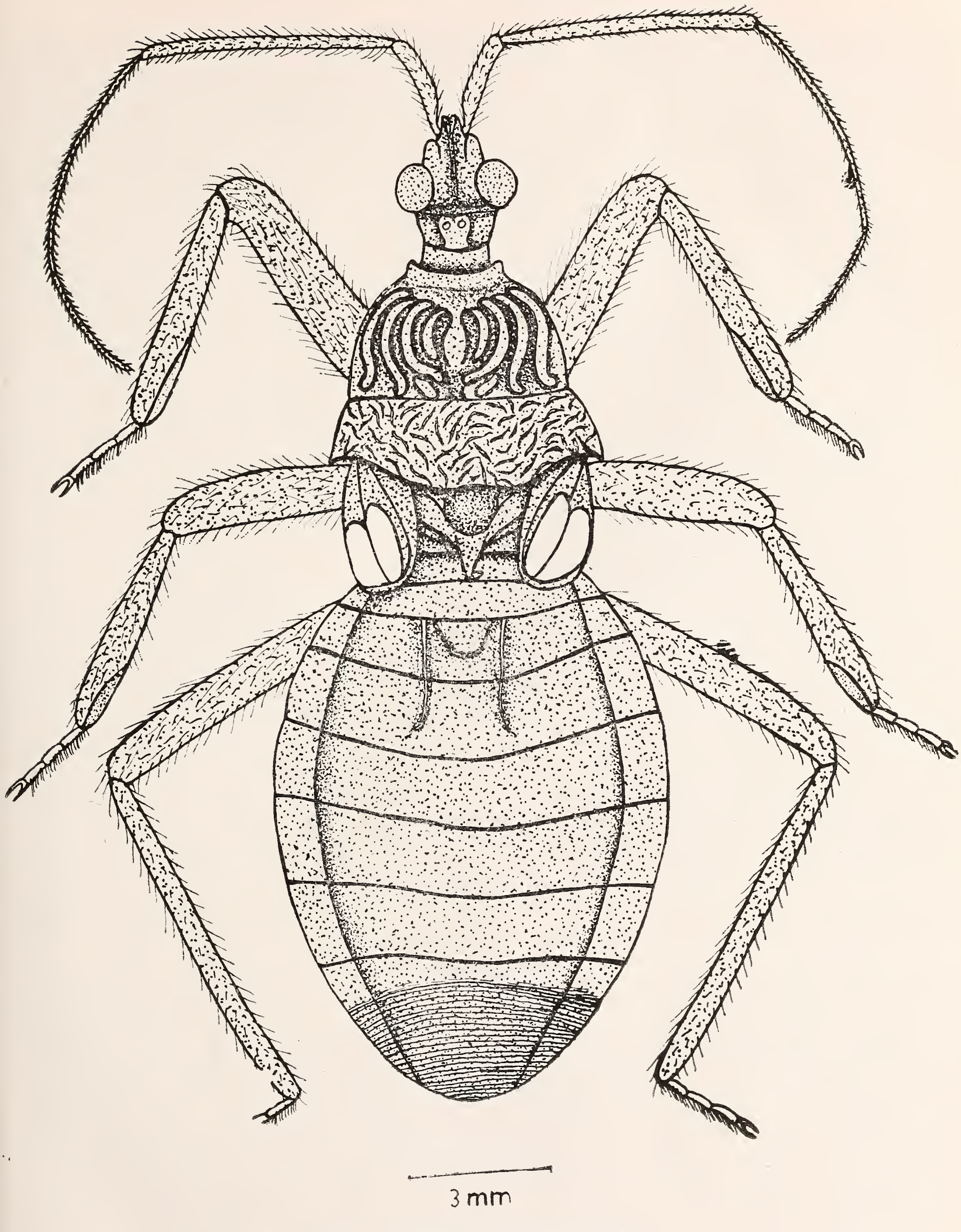


Fig. 1. *Acanthaspis nigripes* sp. nov.

upto the first visible abdominal segment, membranous part opaque and luteous; fore and mid tibiae with well developed tibial pads covering almost 1/3 of the length of the tibia; abdomen entirely smooth dorsally and with a few hairs ventrally; the second and third visible abdominal segments with a prominently formed dorsal carination on either side of the middle line; dorsal abdominal scent gland orifice of the first visible abdominal segment directed towards the dorsum; genital segment dorsally with densely set transverse striations.

This species resembles *Acanthaspis pedestris* in the presence of the pair of carinations on the second and third abdominal segments, direction of the opening of scent gland orifice and in the general formation of the pronotum, but markedly differs from it by its coloration, size, much elongate shape of the body and the head, smoothness of the dorsum, microptery, second antennal segment much elongate than the first and the second rostral segment shorter than the first.

Holotype: Male, serial No. 16, pinned specimen deposited at present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, India.

Collection information: Single specimen, collected from underneath a boulder in the Yelagiri Hills, North Arcot District, Tamil Nadu on 18.4.1984, at c. 1000 m MSL.

Acanthaspis siruvanii sp. nov. (Fig. 2)

MALE: length 18 mm, width across the abdomen 5 mm; micropterous; unicolorous, black; body elongately ovate; head elongately ovate; anterior extension of the frons forked, porrectly terminating just in front of the antennal base; median frontal groove fairly broad at the middle and posteriorly expanding to remain confluent with the deep transverse fissure in front of the transparently white ocelli; a faint ochraceous blotch on the post gena on either side of the ocellar prominence; first joint of the antennae much shorter than head, directed anteriorly, second joint a little longer than the first; first segment of the rostrum a little longer than the second; pronotal sulcations shallow, carinations not conspicuously elevated, both foveations and sulcations unicolorous, black; anterior lobe slightly longer than the posterior lobe, antero- lateral tubercles prominently globose; posterior lobe rugose, discal prominence conspicuous, discal tubercle moderately prominent, postero-lateral tubercle moderately developed, outwardly directed; scutellar spine moderately developed, vertically directed upward, body of the scutellum rugose; meso- and metanota with prominent ridge along their posterior border; wing pad rudimentary, not extending beyond the posterior limit of the mesonotum; legs elongate, pilose, the tibial pads of the fore and mid legs extending almost 1/3 the length; carina on either side of the midline of the second visible abdominal segment well formed, extending upto the middle of the third segment, median posterior rugose expansion of the first visible abdominal segment most conspicuous; dorsum covered with fine short hairs; scent gland orifice of the first visible abdominal segment prominent, posteriorly directed; minute, faintly ochraceous spots on the connexivum of the second to sixth segments, but no median spots; eighth abdominal segment dorsally elevated and transversely striated.

This species closely resembles *Acanthaspis nigripes* in being similar in shape, hue and carination of the second and third abdominal segments, but it can be readily recognised by its micropterous, uniformly dark wing pad that does not extend beyond the mesonotum, nature of development of the mesonotal and metanotal ridged border, presence of rudimentary discal tubercle of the posterior lobe of

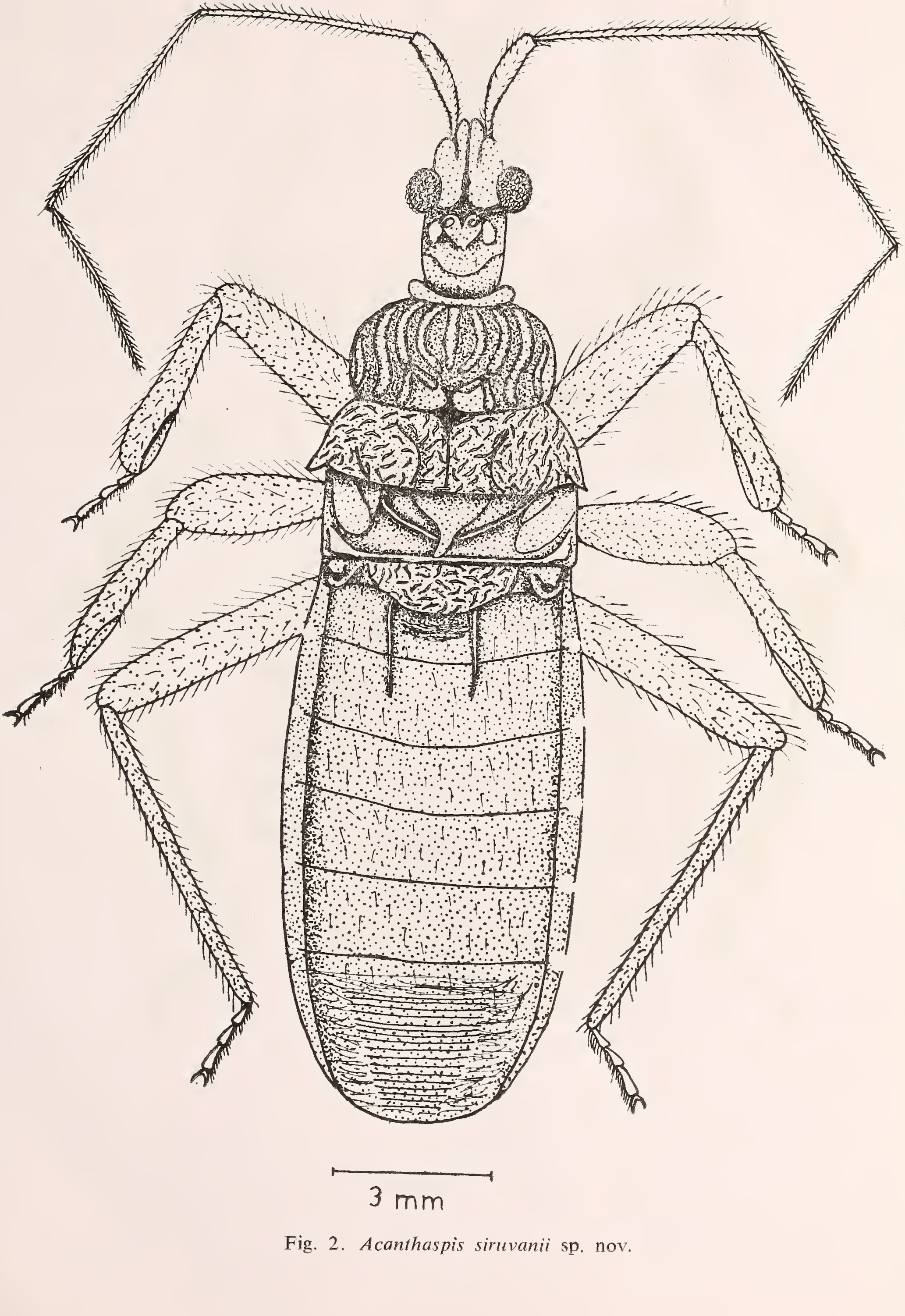


Fig. 2. *Acanthaspis siruvanii* sp. nov.

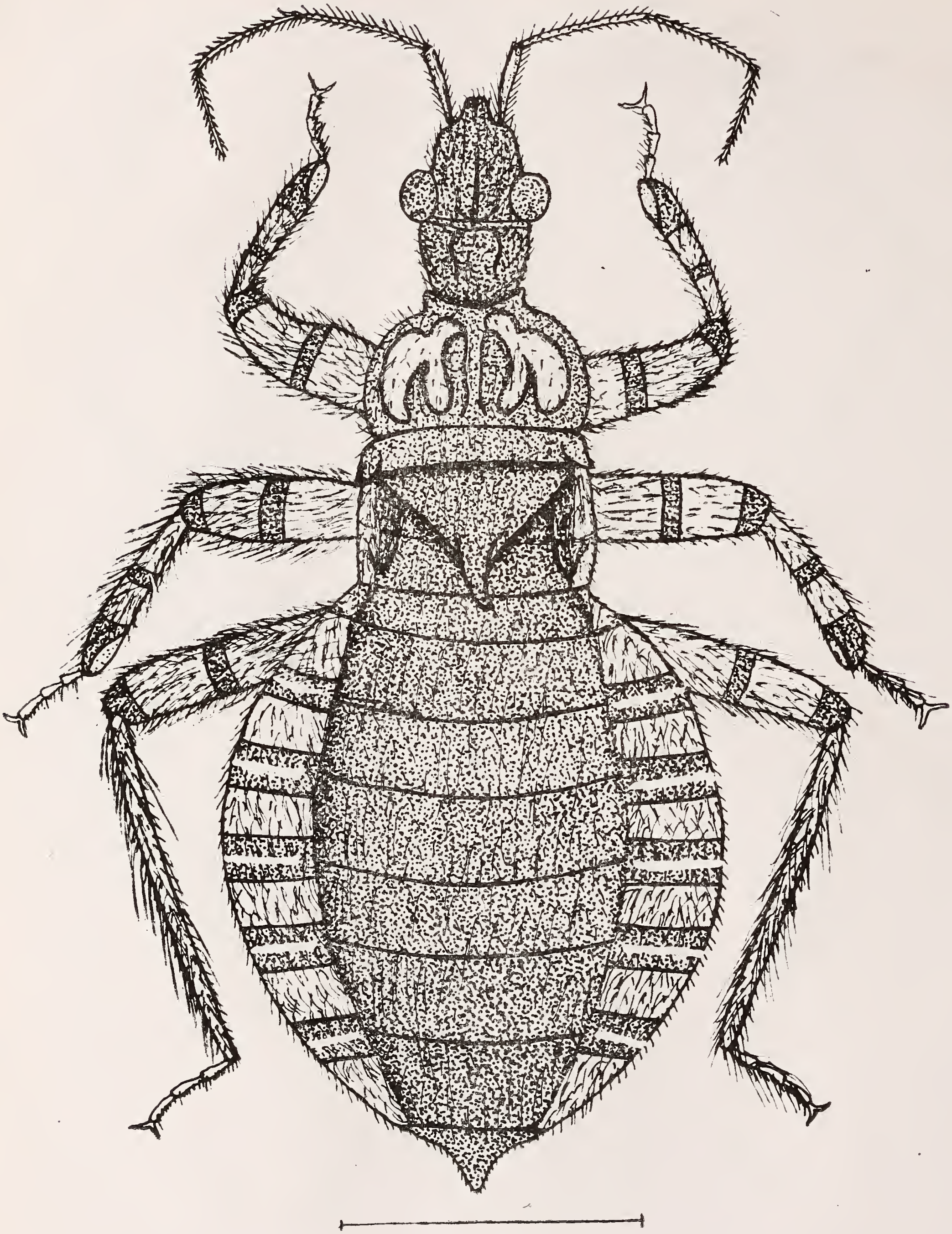


Fig. 3. *Acanthaspis minutum* sp. nov.

the pronotum, ochraceous spots on the connexivum and by the prominently formed median posterior rugose expansion of first visible abdominal segment.

Holotype: Male, serial No. 13, *Allotype*: A single female, both pinned specimens deposited at present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, India.

Collection information: Male and female specimens were collected from underneath bark of a tree in the Tropical Rain Forest region of Siruvani, Coimbatore District, Tamil Nadu on 8.5.1985 at e. 450 m MSL.

Acanthaspis minutum sp. nov. (Fig. 3)

FEMALE: length 7 mm, width across the abdomen 3 mm; apterous; ovate, fuscous with ochraceous bands; densely tomentose; head elongately ovate; deep transverse fissure across the head at the posterior margin of the eyes; ocelli conspicuously absent; postocular and ante-ocular areas subequal; a faint ochraceous spot on the gena behind each eye; antennae pale fuscous, first segment as long as preocular area of the head, slightly incrassated, curved outwardly; second antennal segment annulated, slightly longer than the first; rostrum fuscous, second segment slightly longer than the first; anterior lobe of pronotum globose, much larger than posterior lobe; dorsal carinations fairly well formed, fuscous, its anterolateral tubercles obscure; posterior lobe like a narrow strip behind the anterior lobe, laterally produced on either side as a small tubercle; carinations on the anterior lobe continuous as minute ridges on the posterior lobe; scutellum fuscous, broadly triangular, dorsally punctate, apically produced into moderately elongate, upwardly directed spine; fore femora incrassated, mid femora slightly incrassated with an apical fuscous band; hind femora slender, as long as the tibia, with a subapical fuscous band; abdomen expanded, fuscous, densely tomentose throughout; entire connexivum from first visible segment to seventh segment with fuscous bands dorsally and ventrally, each fuscous band with central ochraceous streak.

This species resembles the female of *Edocla slateri* in the absence of ocelli, general body shape, colour, incrassated first antennal segment and annulations of the legs, but markedly differs from it by its minute size, the greatly reduced posterior lobe of pronotum, the obscurely formed tubercles, the smooth connexivum and the incrassated fore femora.

Holotype: Female, Serial No. 17, pinned specimen deposited at present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, India.

Collection information: Single specimen, collected from underneath stone in the Nagarjuna Sagar Dam site, Andhra Pradesh, South India on 7.7.1985 at c. 200 m MSL.

ACKNOWLEDGEMENTS

We are grateful to the authorities of the Bharathiar University, Coimbatore for providing facilities, and to the Department of Science and Technology, New Delhi for financial assistance.

OBITUARY

REV. BR. ANTONIO NAVARRO, S.J.

(1903-1987)

(*With a plate*)

The passing away of Rev. Br. A. Navarro S.J. on Monday, 5th October, 1987, soon after the demise of Dr. Salim Ali has come as a double loss to the world of ornithology in India. In his single-handed, life-long service to the cause of ornithology, his contributions are singularly outstanding.

Brother Antonio Navarro was born at Manresa, Spain, on 3rd April, 1903 and joined the Society of Jesus in 1919. He was sent to India in 1928 to be assigned, in 1931 to the newly established Department of Microbiology at St. Xavier's College in Bombay under Rev. Fr. Gonzalo Palarios, whom he accompanied to various north Indian hills in pursuit of Markhor and other long-horned goats and sheep. Some excellent heads were obtained. While in Bombay, Br. Navarro collected birds from the nearby hills and forests surrounding Khandala and the neighbouring countryside and later, after he was transferred to the St. Xavier's High School, Bombay, in 1941, worked the areas now known as the Borivli National Park and the Bird Sanctuary at Karnala. He pursued this hobby with great assiduity, devoting most of his spare hours to this study. The total number of birds collected by him is over 2000 and includes some washed up at Versova. His main purpose was to build a museum along the galleries of the school and, to this end, he studied the art of taxidermy. The unmounted specimens are stored in cabinets below the show-cases. This collection has not yet been carefully examined, but doubtless contains interesting specimens.

Apart from the Lesser (short-tailed) Shearwater and the Least Frigate Bird, which were obtained by him from local residents and have added to the list of our avifauna, the bulk of the specimens have yet to be compared with material from other parts of the country and no doubt include material which would add to our knowledge. It is indeed remarkable that he should have made such a representative collection. His work was a source of inspiration to a number of students of the school, including myself, and many of us helped in augmenting the museum collection with specimens of birds and mammals.

The following Indian records were collected by Br. Navarro —

1) Short-tailed Tropic Bird of which only three specimens have been collected so far. It was collected at Versova in 1965.

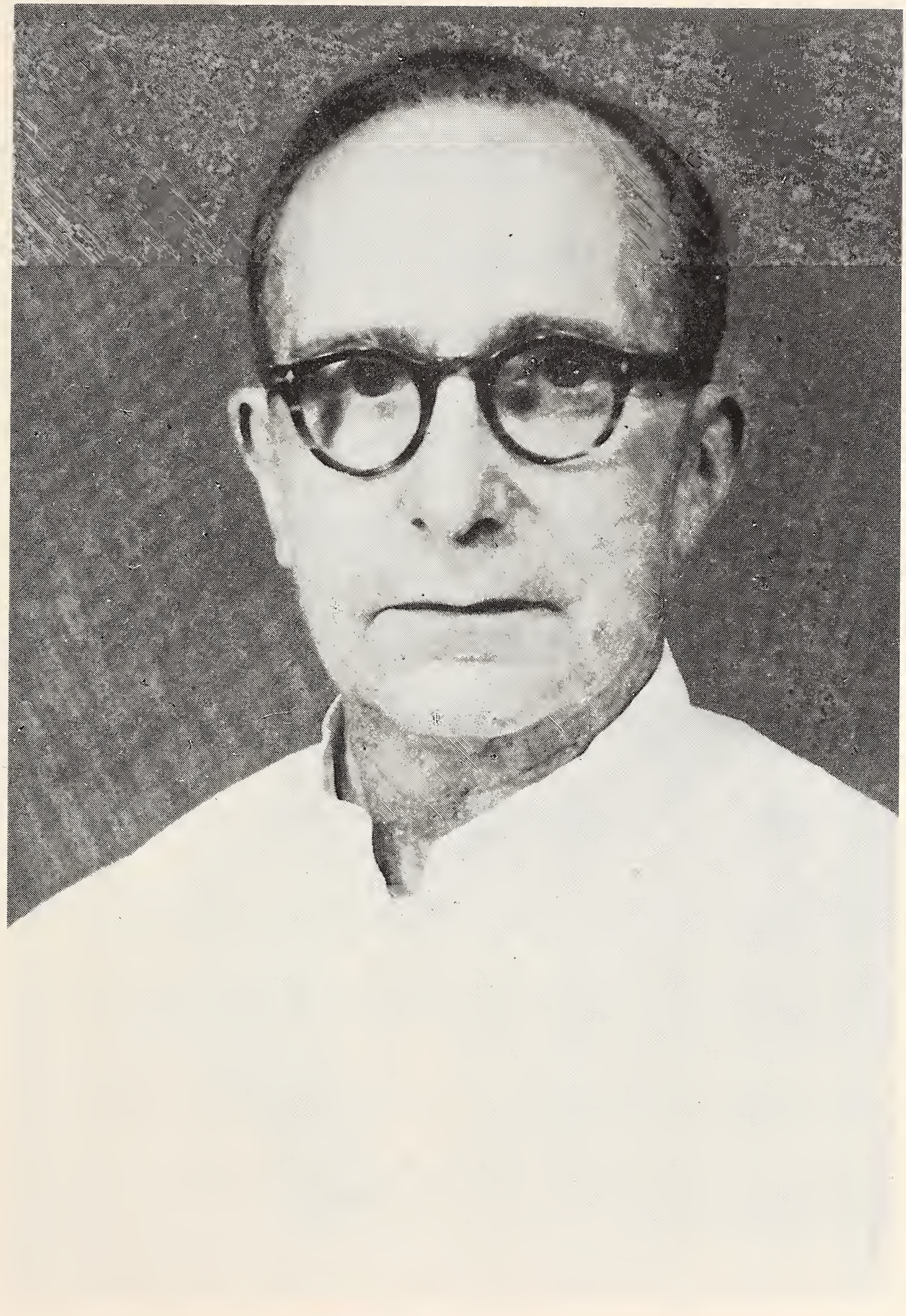
2) Least Frigate Bird — only two recorded in India and collected at Bandra in 1960.

3) A race of *Dumetia hyperythra* was named *navarroi* by H. Abdulali on the basis of several specimens from Khandala.

4) Ashy Minivet — collected in Khandala in 1975.

5) A half-grown Sun fish — the first specimen collected in India — near Bombay.

In addition to the collection of birds and mammals including a good collection of bats and a specimen of the rare rusty-spotted cat, the museum also has a noteworthy collection of about 200 varieties of eggs, some of them



Rev. Br. Antonio Navarro, S.J.
(1903-1987)

obtained with great difficulty. It includes an egg of the rare great Indian Bustard which was presented by the late Dr. Salim Ali.

The museum has also gained acclaim from quite a few visitors from foreign countries, noteworthy amongst them being the curator of the Leningrad Natural History Museum and President of the Natural History Society of Leningrad who paid a visit to the school museum in 1987. In fact there is hardly any other such collection in the country and it is sincerely hoped that some permanent arrangement will be made to properly preserve for posterity this life-time collection of the late Br. Navarro.

In the later years of his life, Br. Navarro developed cataract in both eyes and could no longer spot birds in the field. But undeterred by this handicap, he continued his interest in ornithology and started recording bird calls on a tape-recorder. In this field too he did excellent work, which won him the prestigious first prize in the B.B.C. sponsored world contest on wild-life.

In addition, he also made clay models of dinosaurs and other prehistoric animals which are an added attraction of the museum.

He was a life-member of the Bombay Natural History Society for almost 50 years and added about 600 specimens to the Society's collection. He was a close friend and associate of the late Dr. Salim Ali. He was often invited to lecture to members of the Bombay Natural History Society and other bird-watching clubs and associations at and near Bombay.

Both at St. Xavier's College from 1931 to 1936 and then, when working at the School, he was closely associated with Mr. Humayun Abdulali. I am grateful to him for providing some of the information included herein.

His trips for collection of specimens took him far and wide throughout India to places like Darjeeling, Dalhousie, Kumaon, Kulu and South India and he even visited Nepal and Bhutan. Some incidents in his exciting career stand out prominently; amongst them, when in the company of Shri Humayun Abdulali, a) he descended by rope from the top over the eastern scarp of Mumbra Hill near Thana to get the young of the vulture (*Gyps indicus*) and b) the trip to Talegaon near Poona to get the nest of the Purple Coot. On the way back the car was held up at Thana bridge for the 2nd World War had started in Europe on that day and all Europeans were held up at district boundaries and it was with some difficulty and delay that they were allowed to proceed. He also had a miraculous escape when he rolled down a steep hillside near Dalhousie but was luckily stopped by a tree-trunk. I was lucky to have been able to accompany him on quite a few of his field trips and it was always a matter of great pleasure for me when he visited Vansda, his last trip being one for recording bird-calls, a cassette of which he kindly presented to me. These trips with him will live for ever in my memory and I specially cannot forget how, on the way back from one trip near Khopoli our convertible car failed and we were towed by a break-down van, with guns in our hands, right through Thana town behind a marriage procession, to the amusement of the onlookers and to the utmost embarrassment of us all!

DIGVEERENDRASINH

REVIEWS

1. THE ORCHID FLORA OF NORTH WEST HIMALAYAS. By Som Deva & H. B. Naithani. pp. 1-459 (26 cm. × 21.5 cm.). With 258 text-figures. New Delhi, 1986. Print and Media Associates. Price not indicated on the book.

Both the authors of this book are old associates of Forest Research Institute, Dehra Dun and are known for their critical botanical observations and have to their credit long lists of contributions to taxonomic literature.

Orchid Flora of North West Himalayas is a masterly work and especially the sketches of every individual orchid makes the volume commendable.

The book enumerates 239 species, 66 more than reported eariler by J. R. Dhuthie (1906). Every species is illustrated with meticulous line-drawings made by the senior author.

The size, format and type-script of the book are quite suitable to the subject-matter. However, there are a number of typographical errors still persisting in the volume in spite of the errata appended at the end.

Nomeclature adopted for *Cephalanthus longifolia* (L.) Fritsch (p. 31), *Dactylorhiza hatigera* (D. Don) Soo (p. 109), *Diphylax griffithii* (Hook. f.) Kranzel (p. 119), *Habenaria clavigera* (Lindl.) Dandy (p. 127), *Bulbophyllum yoksumense* J. J. Sm. (p. 223), *Liparis paradoxa* (Lindl.) Reichb. (p. 301), *Cymbidium hookerianum* Reichb. f. (p. 367), *Kingiodium deliciosum* (Reichb. f.) Sweet (p. 407), *Brachycorythis obcordata* (Buch.-Ham. ex D. Don) Summer. (p. 107) requires fresh examination.

The Authors' note on the nomenclature of *Pholidota imbricata* Lindl. (p. 342) clearly shows that they have confused identities and names of two different species.

Acampe carinata (Griff.) Panigrahi, is reported as being used as soothing remedy in Konkan on the authority of Caius. However it appears that this taxon is not found in Konkan areas.

In spite of the few shortcomings, the book is a well presented work both for the technical orchidologists as well as the common orchid lovers and is recommended to them.

M. R. ALMEIDA

2. NAME CHANGES IN FLOWERING PLANTS OF INDIA AND ADJACENT REGIONS. By S. S. Bennet. pp. xvi + 727 + vi (23 cm. × 14.5 cm.). Dehra Dun, 1987. Triseas Publishers. Price Rs. 480.00.

Since the publication of "Flora of British India" by Sir J. D. Hooker (Vols. I-VII, 1872-1897), which gave consolidated account of flowering plants of India and adjoining regions, numerous volumes of books and periodicals have published a number of new species or provided new names for already known plants. These name changes are done as per the rules of International Code of Botanical Nomenclature with the purpose that every plant species should be known by an uniform single name and one scientific name should be applied to one particular species only.

The present book is basically intended to provide a ready guide to the nomenclatural changes that have taken place, up to date, from the time of "Flora of British India" till today.

Initial 603 text pages of the book comprise 5175 entries on nomenclature changes of flowering plants subsequent to Hooker's "Flora of British India". Out of the remaining, 166 pages give an alphabetical index to botanical names and synonyms used in the text, and the last six pages are utilised for addenda, corrigenda and amendanda.

The work of this type cannot be expected to be complete and I have at least another one percent names in my files which can be added in this volume. I would like to compliment the author for making it as exhaustive as possible. However, I would like to record a few observations on the volume as follows:

1. A number of entries given as correct names as per author's judgement require fresh examination, e.g. *Hydnocarpus laurifolius* (Dennst.) Sleumer (See JBNHS. 80: 24-25, 1983).

2. In a number of cases the volume does not give correct chronological priority of acceptance of correct name, which is very important in citations of taxonomic literature, e.g. *Boerhavia erecta* L. was first shown as a correct name for *B. punarnava* Saha & Krishnamurthy by M. R. Almeida (see JBNHS. 65: 266-268, 1968).

3. Very often, accepted names violate rule of priority of publication when compared with synonyms, e.g. *Abutilon muticum* DC. (1813) syn. *A. glaucum* (Cav.) Sweet (1802).

4. Some random decisions regarding status of certain genera require sound reasoning, e.g. Under *Justicia japonica* Thunb. The author comments, "Treating *Justicia* L. (1753) in broader sense including *Rostellularia* Reichb. (1837) appears to be the appropriate taxonomic treatment for this group". Such statement without giving any sound reason is out of place in this volume. Rev. Fr. H. Santapau, who revised of Acanthaceae of Bombay Presidency has accepted *Rostellularia* Reichb. as a distinct genus and most modern taxonomists follow his concept.

5. Personal verification regarding some entries in this book seems desirable, e.g. *Ecbolium viride* (Forsk.) Alston var. *dentata* (Klein ex Link) Raizada ex Santapau.

The nomenclature here is completely misleading. In 'Flora of Khandala' H. Santapau does not mention Raizada as cited here. The actual varietal combination is made on varietal name of Clarke in FBI and not on reduction of species by Klein ex Link (1820), as accepted by the present author.

6. Author's explanations regarding status of certain genera are not always properly placed, e.g. treatment of *Rostellularia* Reichb. (1837) as congeneric with *Justicia* L. (1753) is explained after 7th species.

Indian taxonomists, many of whom do not have adequate facilities to refer to reliable original literature, will definitely find this book useful and handy.

I did not expect the compilations of this type to cost so high.

M. R. ALMEIDA

3. TIGERS OF THE RAJ — THE SHIKAR DIARIES OF COLONEL BURTON 1894 TO 1949. Edited by Jacqueline Toovey. pp. 295 (18 × 25 cm.) with many photographs and sketches. Britain, 1987. Alan Sutton Publishing. Price £ 12.95.

The scope of this book goes well beyond a collection of shikar stories about tigers. Big-game shikar and fishing are no doubt central themes, but there is also a great deal of information about the forests and wildlife of the Indian sub-continent. And the reader makes the acquaintance of a remarkable man, a distinguished sportsman who became an active conservationist, and a man who showed exceptional hardihood in the face of severe physical misfortunes.

Colonel Richard Burton was born in Madras in 1868. He was commissioned from Sandhurst and first joined his Regiment in India in 1890. In December 1903, when he was posted in Aurangabad, he had a riding accident and had to be moved to England. He returned to India three years later, permanently crippled; his left leg was shortened by four inches.

Burton was allowed to join the Cantonment Magistrates Department, and he retired from service in 1923. Though 55 years old, he continued to undertake expeditions which would have taxed the endurance of a fit young man.

March 1926 saw Burton on the trail of a man-eating tigress in the jungles of Betul. A machan he was building collapsed, and he fell, breaking an arm and a leg. A slow and painful journey eventually brought him to Nagpur, where he had to spend 106 days in hospital. Burton took this set-back in his stride, as he had done many other mishaps in the jungles, such as the bite of a Bamboo snake, a severe mauling by an infuriated bear, bouts of enteric fever, malaria and pneumonia, and so on.

In 1933, the Burtons settled down in Coonoor and they left India twenty years later. It seems that between 1894 and 1949 the Colonel must have spent every free hour in India, and every rupee he could muster from a none too generous income, in the single-minded pursuit of his twin hobbies, shikar and natural history.

'Tigers of the Raj' presents, in a loose time-frame, extracts from Burton's shikar diaries and articles in the Journal of the BNHS. These extracts are strung together by short editorial passages which aim to provide continuity. With this format it is not too easy to read (or review!) the book, and at times one is apt to get confused about dates and places.

A glance at some of the chapter headings gives an idea of the change of the Colonel's wanderings: Raichur, the Deccan, Jeypore (Orissa), the valley of the Sutlej, Kashmir, the Kumaon hills, the C. P. jungles, Baluchistan, Pachmarhi, Burma, Ceylon, the Laccadives, the Nilgiri Hills, and finally, a coffee estate in Cochin, where, at the age of 79, Burton shot a man-eating tiger.

The shikar diaries, which were written 'on the spot', have a matter-of-fact style, with British understatement and a light touch much in evidence. Here is an extract regarding a beat at Keshpur (near the Godavari) on 25 May, 1894:

" . . . I just had time to swing my gun over his (Sexton's) head and take a snap shot behind the line, hitting the tigress in the shoulder . . . as she was actually in the air in front of Sexton. She got him by the upper left arm in her mouth, and one forepaw on his head and the other on his left hand, and knocked him over backward. He rushed up and forced her jaw open and released his arm. Tigress was gasping and I fired my left barrel into her head. Sexton was very white and faint from shock..."

Next morning, the party arrived at a small village and tried to get a doctor. When bathing Sexton's feet, writes Burton, "I heard the death rattle in his throat, and he threw out his right arm as if pointing at something and died in my arms." The report ends with a comforting remark about Sexton's tombstone at Yellandu: "All was in good order when I saw it in 1903 ..."

Burton's observations were not limited to shikar, as shown by this extract from the Journal: "All these mountains ... are clothed in forest in which elephant, bison, tiger, sambar and all lesser jungle animals roam at will. The people of the hills are Mannans, but in a deep mysterious valley below the western slopes, the human race is represented by a tribe of extremely primitive people called Pandarums. True dwellers of the forest they are, having bark of trees for their clothing, and rocks, caves and hollow trees for their houses ... before long they must become extinct." These observations were made when going "over the winding waters of the lake (Peryar) to Thanakudi".

Burton was elected a member of the BNHS in 1893, and over the years he collected many specimens for the Society. On his expedition to the Northern Irrawady in 1930 he was requested to obtain a Saing. A new note is heard in the diary entry: "Beast too heavy so could take no front face photo. Curator of the Museum must do with this photo and that of the bull I took at Manwa lick ... Poor old Saing; a shame to have killed him; lovely eyes and eyelashes ..."

Burton was well on the way to becoming an active conservationist. In later years, as Dr. Salim Ali has written, his was the strongest voice in the BNHS pressing for a conservation policy, and it was his missionary zeal which made the BNHS take up the cause in good earnest, culminating in the formation in 1952 of the Indian Board for Wildlife.

These and many other aspects of Burton's life and times are barely touched upon in the book. 'Tigers of the Raj' is not a biography, nor is it an adventure story. It is the sort of volume that one dips into from time to time over a long period, and with great enjoyment. An attractive production with a good collection of old photographs, it can be recommended to all readers of the Journal who do not have a strong prejudice against shikar. As the good Colonel puts it:

"I think of the interest and unending enjoyment there is in the mere living of the jungle life, and it is this, more than shikar, which forms the main attraction ..."

PRATAP SARAIYA

MISCELLANEOUS NOTES

1. THE STUMP-TAILED MACAQUE (*MACACA ARCTOIDES* I. GEOFFROY) IN ARUNACHAL PRADESH

During a recent field survey (February, 1987) of the eastern part of Arunachal Pradesh a male stump-tailed macaque was obtained in Bhogamur village forest, Lohit district from a local hunter, who had shot it a little while earlier. The specimen constitutes the first authentic record of this species from Lohit district in Arunachal Pradesh. The Lohit district lies approximately between 27°-33′ N and 29°-22′ N and 95°-15′ E and 97°-24′ E and borders Tibet on the north, Burma on the east, Siang district on the west and Assam on the south.

Habit and Habitat

The forest habitat of this species under study stretches between Bhogamur and Jengto villages in the northwest of Namsai harbouring a small population which is estimated to be about 15 in number. The river Jengto is in the vicinity of Bhogmur village. The vegetation of the forest is thick with tall trees growing closely with widespread canopy. Most of the trees are interwined and enmeshed by a variety of woody climbers. Besides, thick clumps of a variety of bamboos are also present in abundance.

Remarks

Kurup (1968) recorded this species in Assam and Nagaland. It also occurs in Nongstoin, Khasi-Jaintia Hills district of Meghalaya (personal communication from Mr. R. K. Lahiri, Superintendent, Zoological Garden, Calcutta to Dr Kurup). The presence of this species in Arunachal Pradesh thus fills up the gap in their continuous known range of distribution. Further intensive survey of this species may add substantially to our knowledge.

Acknowledgement

I am deeply indebted to Mr. C. P. Namchoom, MLA, Namsai, Arunachal Pradesh for his help in various ways.

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September 4, 1987.

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Reference

Kurup. G. U. (1968): Mammals of Assam and adjoining areas 2. Distribution list. *Proc. Zool. Soc.* Calcutta, *21*: 79-99.

2. SHORTNOSED FRUIT BAT (*CYNOPTERUS SPHINX* VAHL) FEEDING ON THE LEAVES OF *CASSIA FISTULA* AT POINT CALIMERE WILDLIFE SANCTUARY

To study the role of seed dispersal by mammals, the faecal samples and chewed-off remains dropped by Shortnosed fruit bat were collected from Point Calimere sanctuary during different seasons of the year. From the studies it was evident that fruits of nearly 25 plant species were eaten and dispersed by these bats. Apart from the fruits and seeds dropped under their roosting sites, I noticed one to many chewed-off leaflets of *Cassia fistula* during every collection trip (twice a week). The occurrence of only *Cassia fistula* leaves in their droppings throughout the year indicates that the *Cassia fistula* leaves form a supplement to the regular diet of the Shortnosed fruit bat.

The literature (Brosset 1962, Prater 1980) says that Shortnosed fruit bats feed on fruits and sip honey from flowers. So it will be worth noting that *Cassia fistula* leaves are also one of the food items of the Shortnosed fruit bat.

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Point Calimere-614 807,
Thanjavur (Dist.),
January 15, 1988.

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Brosset, A. (1962): The Bats of Central and Western India; part 1. *J. Bombay nat. Hist. Soc. 59*: 1-57.

Prater, S. H. (1980): The book of Indian Animals. Bombay Natural History Society, Bombay. pp. 187A-187B.

3. SCAVENGING HABIT OF FISHING CAT (*FELIS VIVERRINA*) IN KEOLADEO NATIONAL PARK, BHARATPUR

While returning from field work at about 6 p.m. on February 4, 1987 I was attracted by the noise of a carnivore feeding from a nearby bush. I searched and located the carcass of a cow with a fishing cat feeding on it. The cat slipped away with a piece of flesh on sighting me.

The larger cats (tiger) are known to feed on carrion (Prater 1965), but I am unaware of earlier records of scavenging by the fishing cat.

My thanks to Drs. V. S. Vijayan and Lalitha Vijayan for encouragement.

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Bharatpur 321 001,
May 12, 1987.

REFERENCE

PRATER, S. H. (1965): The Book of Indian Animals, Bombay Natural History Society, Bombay.

4. MELANISM IN THE JUNGLE CAT, *FELIS CHAUS* GULDENSTAEDT (FELIDAE: CARNIVORA)

In connection with the revision of Indian Felidae, one of us (S.C.), while studying the material of Bombay Natural History Society, came across three melanistic specimens of the Jungle Cat, *Felis chaus* Güldenstaedt from India. Although Pocock (1939) and Roberts (1977) have earlier reported the occurrence of melanistic specimens of the Jungle Cat, *F. c. prateri* Pocock from Karachi, Tharparker and Thatta, all in Pakistan, there is no record of melanism in the Indian subspecies of this cat. It is being recorded in the present note. The details of the specimens are given below. External measurements were taken by the collector. The cranial measurements are taken after Pocock (1939). Measurements are given in millimetres and abbreviations used according to Chakraborty (1983).

BNHS Reg. No. 6044; study skin: loc. Arcadia Tea Estate, Tamil Nadu (?); 22 Feb. 1940; coll. P. N. Jackson.

No pattern could be marked; entire dorsum including tail dark brown, with some fine pale cream grizzling except in mid-dorsal region; undersurface similar but pale bands broader than those of dorsum, particularly on the chin, throat and belly, giving a somewhat speckled appearance on venter.

BNHS Reg. No. 6035; study skin and damaged skull; loc. Belgaum, Karnataka; 5 Dec. 1912; coll. T. J. Spooner.

Measurements: Hb 520; Tl. 292; Hf 119; E 57.

Partially melanistic; dorsum including tail dark brown; sides agouti; throat, a portion of chest and undersurface of forelimbs infused with dark brown hairs.

BNHS Reg. No. 6018; study skin (damaged) and skull; loc. Tikoli, 22.5 km from Gwalior, Madhya Pradesh; Feb. 1914; coll. W. E. Jardine.

Measurements: Gl. 111; cb 100; pm^4 11, M^3 9; M$_3$ 7; Pw 33; Iw 19; Zw 72; Mw 24.

Entire dorsum including tail and limbs dark brown; sides of the body and cheek having some fine pale cream hairs.

Discussion: It is a known fact that melanin pigmentation is more strongly developed in the hot humid areas (Gloger's Rule). The two specimens from south India support this hypothesis, but the specimen from Gwalior and those reported from Pakistan are exceptions, being inhabitants of warm, dry areas.

ACKNOWLEDGEMENTS

We are grateful to the Director, Zoological Survey of India for extending all the facilities for this work. We are thankful to Mr. P. K. Das, Scientist 'C' for valuable suggestions. Thanks are also due to Mr. J. C. Daniel, Curator, Bombay Natural History Society, for permission to examine the material at the Bombay Natural History Society.

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R. CHAKRABORTY
V. C. AGRAWAL

Bombay Natural History Society,
Hornbill House, S. B. Singh Road,
Bombay 400 023,
October 8, 1987.

MANOJ MUNI

R e f e r e n c e s

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5. SOME OBSERVATIONS ON FOOD HABITS OF JACKAL (*CANIS AUREUS*) IN KEOLADEO NATIONAL PARK, BHARATPUR, AS SHOWN BY SCAT ANALYSIS

Food habits of jackal were studied in Keoladeo National Park, Bharatpur from September, 1984 to August, 1985 by scat analysis. Altogether 102 scat samples were collected and analysed. The hair samples from the scats were identified in the field with naked eye comparing with hair samples kindly given by Bombay Natural History Society. Results are given in Table 1. Samples collected from December to March had *Zizyphus jujuba* fruits. Seeds of Date palm (*Phoenix sylvestris*) and Jamun (*Syzygium cumini*) were also observed in their scats during June and July respectively.

Table 1

Percentage frequency of each food item of jackal at Keoladeo National Park, Bharatpur (Sep. 1984-Aug. 1985)

Food items	No. of times occurred	Percentage
Rodents	45	26.5
Birds	41	24.1
Grass	34	20.0
Fruits	28	16.5
Insects	7	4.1
Snake	7	4.1
Chital	4	2.4
Nilgai	2	1.2
Fish	2	1.2

Feathers of coot (*Fulica atra*) and Grey partridge (*Francolinus pondicerianus*) were identified from their scats.

Chital and Nilgai hair were found in 2.4 and 1.2 per cent of the remains. However this low figure probably represents scavenged food rather than prey killed by the jackals themselves.

According to Schaller (1967), jackals occasionally catch hares. Even though hares (*Lepus nigricollis ruficaudatus*) are fairly common in Bharatpur, their remains were not seen in jackal scats. This may be largely because of my inability to identify the hair of hare in the field. Similarly remains of Blackbuck (*Antilope cervicapra*), Sambar (*Cervus unicolor*), feral cattle (*Bos indicus*), wild boar (*Sus scrofa*) and Rhesus macaque (*Macaca mulatta*) were also not observed.

Broad ventral scales of snakes, possibly of python, were also seen. Whether they kill python or scavenge is not known. However, three jackals trying to attack a 2 m. long python have been recorded by Bhupathy (1986). On the contrary, Singh (1983) records that in Corbett Park python is a predator on the jackals.

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P. O. NEW FOREST,
DEHRADUN (U.P.) - 248 006,
December 23, 1987.

ACKNOWLEDGEMENTS

I thank Dr. V. S. Vijayan for providing facilities to work at Bharatpur and Dr. A.J.T. Johnsingh for his comments.

K. SANKAR

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6. INTERACTION BETWEEN DHOLES (*CUON ALPINUS*) AND A PYTHON (*PYTHON MOLURUS*) IN MUDUMALAI WILDLIFE SANCTUARY, TAMIL NADU, INDIA

On 31st Aug. 1986 between 1500 and 1520 hrs. an elephant mahout, while looking for his elephant in the forest, saw a huge python (*Python molurus*) attacking a yearling Chital (*Cervus axis*) doe. As the snake [our estimate was 14 to 15 feet (*c.* 4.5 m.) long] coiled itself around the deer, a pack of 8 Dhole (*Cuon alpinus*) which were hunting nearby immediately rushed to the spot. A couple of the dogs boldly darted in to grab a few bites off the rump of the deer, even as the python was killing the deer. At this point the mahout, not wanting the python disturbed, chased the dholes away and returned to the elephant camp to report his sighting.

We were informed just as we returned from our field work and managed to reach the spot at 1655 hrs. The dholes were about 60 m. from the python. They had probably just returned and had apparently not interfered with the snake which, by now had already swallowed the entire neck of the chital. A few minutes after our arrival the dholes moved off and the python proceeded to swallow the entire deer by 1731 hrs.

This incident raises a lot of interesting questions. Would the dholes have stolen the kill had they not been chased away by the mahout? Would the python leave its kill or would it try to defend it? Would the dholes attack the python also? Dholes are known to drive away tigers (*Panthera tigris*) and leopards (*Panthera pardus*) from their kills and at times even kill these predators. As they had already snatched a few bites from the deer, there is a strong reason to believe that they would have stolen the kill, had they not been driven away. If the dhole had attacked the python itself, it might have abandoned its kill and escaped into the dense Lantana (*Lan-*

tana camara) bushes nearby. If they were to come across a python while it was in the process of swallowing its prey, the snake would be helpless and it would be easy prey for the dholes if they decided to attack it.

Dholes have been recorded to drive away tigers and leopards from their kills, but this is probably the first record of dholes trying to steal a kill from a python.

BNHS Elephant Project,
Kargudi,
Nilgiris - 643 211,
Tamil Nadu,
November 17, 1987.

AJAY A. DESAI
N. SIVAGANESAN
S. RAMESH KUMAR

7. ALBINO SLOTH BEAR

The tribals of village Madakote. Block Marwahi in Bilaspur District, located a female Sloth Bear with three white cubs in an Arhar (Pulse) field, adjacent to the forests of Achanakmar Sanctuary which is very rich in flora and fauna. Out of curiosity they chased the bear family and managed to capture the smallest of the three white cubs. The mother with two other cubs escaped. The tribals brought the captured cub to Police Station and from there to the Range Forest Officer, who kept it in the department's 'Indira Udyan' at Pendra. After the release of the news about this animal in local press, it has received much publicity and is a subject of great attraction.

The captured cub is a female and has been named 'KAMLI' by its keeper; its companions in the enclosure are a female Barking Deer (*Muntiacus muntjak*), Pea-fowl (*Pavo cristatus*), Blue rock Pigeons (*Columba livia*) and domestic ducks.

The cub was about 3-4 months old, attained three feet height when it stood erect and weighed about 30 kg. It is completely white, and the eyes are pink.. It is difficult to distinguish the white 'V' mark on the chest, which is otherwise distinctly clear in normal coloured species. The snout and adjacent upper muzzle portions are light pinkish, replacing the dirty white coloration. The cub is shy of bright sunshine.

The mother of the cub is of the normal black coloration. The father could be the white coloured male which was reportedly seen sometimes in 1980 in the area. However, there are no evidence of its having been seen thereafter. The cub, a nature's freak, is therefore possibly an offspring of normal coloured parents. It appears to be a clear case of albinism and is possibly a rarity. The forests of Pendra have produced albinos in the past also, one of the earliest recorded instances being that of a tiger, shot in Pendra Zamindari (*JBNHS* XXIV No. 4. Page 819) whose skin (7′ 6″ long) was brought to Mr. E. A. D'Abreu of Central Museum, Nagpur in 1916.

Albinism in Sloth Bear, and in other species, of this particular forest tract, could therefore, be an interesting subject for investigation.

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September 15, 1987.

A. M. K. BHAROS

8. NOTES ON THE FOOD HABITS OF NILGIRI TAHR

In the course of a study on the behaviour and ecology of Nilgiri tahr (*Hemitragus hylocrius*), anecdotal records were kept on tahr food habits as determined by direct observation. The study was carried out in Eravikulam National Park, Kerala, August 1979-September 1981 (Rice 1984).

Forbs exceeded grasses in number of species eaten by Nilgiri tahr (Table 1), but grasses were taken in much greater volume than any of the forbs, shrubs or trees. At Eravikulam, Nilgiri tahr were primarily grazers (Table 1).

Nilgiri tahr showed preferences for particular parts of certain plants. For instance, they ate only or mainly inflorescences of *Hypericum mysorense, Pedicularis perrottetii, Crotalaria fysonii, Carex lindleyana, Anaphalis lawii, Anaphalis bournei,* and *Eriocaulon brownianum.* This habit was particularly noticeable in the case of *Anaphalis lawii* and *Eriocaulon brownianum.* When tahr grasped the flowering heads of these plants, the entire plant (in the first case), or the whole flowering stem (in the second) usually was pulled free. Rather than eating the portion of the plant hanging from their mouths, the tahr chewed through the stems to drop the rest of the plant. On the other hand, tahr took only the tender new leaves of *Gautheria fragrentissima* while avoiding the mature leaves. The mature leaves had a characteristic wintergreen flavour, but were bitter.

Two uncommon plants which seemed to be particularly well liked were *Lactuca hastata* and *Impatiens tomentosa.*

There were some species which the tahr seemed to avoid, or at least were never seen to eat despite their ready availability. Such plants included *Rhododendron arboreum* and the grassland species of *Impatiens.*

There appeared to be pronounced seasonal

TABLE 1

PLANTS RECORDED EATEN BY NILGIRI TAHR IN ERAVIKULAM NATIONAL PARK

Species	Family	Type
Ranunculus reniformis	Ranunculaceae	forb
Polygala sibirica	Polygonaceae	forb
Hypericum mysorense	Hypericaceae	shrub
Eurya japonica	Ternstroemiaceae	shrub/tree
Impatiens tomentosa	Balsaminaceae	forb
Crotalaria fysonii	Fabaceae	forb
Crotalaria scabrella	Fabaceae	forb
Oldenlandia swertioides	Rubiaceae	forb
Anaphalis bournei	Compositae	forb
Anaphalis lawii	Compositae	forb
Eupatorium adenophorum	Compositae	forb
Lactuca hastata	Compositae	forb
Wahlenberia gracilis	Campanulaceae	forb
Lobelia sp.	Campanulaceae	forb
Vaccinium leschenaultii	Vacciniaceae	forb
Gautheria fragrantissima	Eriacaceae	shrub
Pedicularis perrottetii	Scrophulariaceae	forb
Sopubia trifida	Scrophulariaceae	forb
Strobilanthes kunthianus	Acanthaceae	shrub
Polygonum chinense	Polygonaceae	forb
Elaeagnus kologa	Elaeagnaceae	forb
Curculigo orchoides	Hypoxidaceae	forb
Cyanotis sp.	Commelinaceae	forb
Eriocaulon brownianum	Eriocaulaceae	forb
Carex lindleyana	Cyperaceae	sedge
Andropogon polyptichus var. *deccanensis*	Poaceae	grass
Chrysopogon zeylanicus	Poaceae	grass
Tripogon bromoides	Poaceae	grass
Tripogon ananthaswamianus	Poaceae	grass
Ischaemum indicum	Poaceae	grass
Arundinella mesophylla	Poaceae	grass
Agrostis peninsularis	Poaceae	grass
Arundinella fuscata	Poaceae	grass
Andropogon polyptychus var. *olyptichus*	Poaceae	grass
Andropogon lividus	Poaceae	grass
Themeda quadrivalvis	Poaceae	grass
Themeda triandra	Poaceae	grass
Isachne bourneorum	Poaceae	grass

preferences for certain species and/or plant parts. For example, after pre-monsoon burning of the grassland, the tahr eagerly took the fresh regrowth of *Chrysopogon zeylanicus* by grasping the leaf blades and pulling out the whole succulent stem. However, as the blades matured, less was taken. With the post-monsoon drying of the grassland the inflorescences were eaten from time to time, and the *Chrysopogon* growing in the wetter, low lying areas was taken more frequently. The grassland dried even more during the winter (January-February) and this was considered the time of lowest forage quality for Nilgiri tahr. My subjective impression was that the tahr's rate of movement while grazing was much faster, suggesting a lower density of acceptable food items. Normally they occasionally entered small *shola* patches a few metres wide, but during the dry season they penetrated up to 10 m into the larger patches, browsing on trees and shrubs.

Nilgiri tahr feed on a variety of plants. Their selection of food items in terms of species and plant parts probably reflects seasonal changes in nutritional quality and availability. The actual diet of Nilgiri tahr probably varies considerably between localities, as it does for bighorn sheep (Shackleton & Shank, in press). Nilgiri tahr in much drier lowland habitats are primarily browsers (Davidar 1978).

I am grateful to N. C. Nair, P. V. Sreekumar, and P.V.K. Nambiar for identifying plant specimens.

CLIFFORD G. RICE

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9. SEX RATIO IN *LEPUS NIGRICOLLIS*

On 31st March, 1983 I was in a ravine in panchayat land at Village Baskarnawat in Bansur Tehsil in Alwar district. Between 1600 and 1730 hrs. the labour who were with me killed six common hare (*Lepus nigricollis*). All were females (i.e. sex ratio between ♂ and ♀ was 0:6). All were lactating, as I found out by pinching their teats. I examined their uterus all of which were empty.

It was interesting that among the six hares killed none were male. It was perhaps due to dissimilar sex ratio between male and female animals or due to some post-parturition weakness which prevented females from being speedy enough to escape when chased.

SATISH KUMAR SHARMA

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August 4, 1987.

10. PURPLE HERON (*ARDEA PURPUREA*) SWALLOWING A JUNGLE BABBLER

On February 26, 1979, Shri Hukum Chand, Forester of Bharatpur Sanctuary and I were crossing the irrigation canal 1 m deep and 3 m wide, just outside the sanctuary across the new road on the east when we stopped on hearing house crows. A purple heron *Ardea purpurea* adult was sitting about 10 m away on a Babul tree, holding a dead full grown jungle babbler, *Turdoides striatus* across near the tip of its beak. Five House crows were worrying the heron, they flew over and at the heron. The jungle babbler was full grown, and did not have any wounds. The heron tossed the jungle babbler in the air, caught it, head first and swallowed. It took 27 seconds for the jungle babbler. to travel the length of the heron's slender neck, as a conspicuous bulge.

J. MANGALRAJ JOHNSON[1]

WILDLIFE WARDEN,
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TEMPLETOWN COTTAGE,
VANNARPET,
UDAGAMANDALAM 643 001,
April 12, 1986.

---

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11. RECOVERY OF A NORWEGIAN RINGED OSPREY IN GUJARAT, INDIA

On November 5, 1985, Mr. A. N. Jadeja saw a large bird falling into his field after having collided with a high tension electric line near Kajurda village (22°20′ N, 69°42′ E), Jamnagar district. Gujarat. The bird was dead when picked up and had a ring on one leg. He removed the ring (Museum Stavanger Norway, 231503) and buried the bird. I learnt about this incident in the market place of Jamnagar, met Mr. A. N. Jadeja and contacted the Museum Stavanger. The Museum informed me that the bird was an Osprey, *Pandion haliaetus* (Linné), ringed as a chick on July 13, 1985 at Hastfoss (69°07′ N, 29°04′ E), Norway. This would mean that the young bird had flown a distance of at least 5855 km. This is probably the first record of a European ringed Osprey recovered in India. The Osprey is a winter migrant to most of the Indian subcontinent, with a few possible nesting pairs in the Himalayas (Ali and Ripley 1982).

TAEJ MUNDKUR

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May 30, 1986.

REFERENCE

ALI, SALIM & RIPLEY, S. DILLON (1982): Handbook of the Birds of India and Pakistan. Compact Edition. Oxford University Press, Delhi.

12. NOTES ON FEEDING BEHAVIOUR OF *AMAURORNIS PHOENICURUS* AT POINT CALIMERE

On 4th January 1986, at the water's edge of a small pond at the Avifauna office compound, we noticed a Whitebreasted Waterhen feeding on small water insects and fish. It was seen turning its head left and right at very low angles, at the same time its short stumpy tail was cocked up and down. Even though it was moving vigorously in search of food it could not get any for about 15 minutes. It slowly walked into the water and then started swimming in the deep water to the centre of the pond where there was a school of fish fry. While swimming, the white underbody was completely invisible. Like duck swimming on water it was swimming as well as pecking some food material from the water surface. Each time the swimming continued for a few minutes and at the end it came to the shore and shook its body vigorously to get rid of water particles. The same process was repeated about 5 times during our 30 minutes observation. The feathers did not seem to be wet. This type of feeding behaviour in Whitebreasted Waterhen has not been recorded before in literature.

As per the HANDBOOK Vol. 2, pp. 171 their habitat is rice fields, ponds, ditches, backwaters etc. In Point Calimere we have come across them feeding in places where the salinity of water was over 4 ppt.

AVIFAUNA PROJECT (BNHS),
POINT CALIMERE,
KODIKKARAI 614 807,
TAMIL NADU,
April 29, 1986.

R. SUGATHAN
S. ALAGAR RAJAN

13. A NEW NESTING COLONY OF RIVER TERNS AND PRATINCOLES

The point that this note wishes to make is how one chance observation can lead to a succession of others that link up all of them into a complete picture.

Over the last several years E. K. Bharucha has been observing the changing patterns of bird populations at the Mula-Mutha bird sanctuary in Pune. The population of terns has been steadily increasing since around 1975. Earlier, the Gull-billed terns were much commoner than River terns. However, during the last 2 to 3 winters the river terns have shown periods of sudden increase in their population. Last year they outnumbered the Gull-billed terns for several months.

In Aug.-Sept. it was further noticed that many of these River terns were immature birds. Counts taken on several visits to Mula-Mutha showed that the ratio of adults to juveniles was about 2 to 1, and on one visit it was as high as 1:1. This gave the impression that perhaps the river tern had set up a new breeding colony nearby. Presuming that the nesting area should be only a couple of miles away at most, islands downstream near the Mundhwa bridge and at Kaudi were inspected, but nothing was found.

However, in April, 1986, while observing the Flamingoes at Bhigwan 100 km downstream from Pune, two large islands were found to be the nesting colonies of a mixed group of River terns and Pratincoles. The villagers claim that the birds have been nesting there over the last 2 to 3 years, thus accounting for their rise in population upstream.

The greater proportion of nests are found in the middle of the islands which are about 2-3 feet above and several yards from the present water-line. This area is covered by sparse grasses and other weeds and the nests are close to each other, varying from 1 to 10 feet apart. The proportion of tern nests to pratincole is about 2 or 3 to one. Most of these centrally situated nests contain river tern chicks of varying ages while some still have one, two or occasionally 3 eggs (4 in one case). Pratincole nests in this area have at present 2 to 3 eggs each and only a few have new born chicks.

The periphery of the island shows a different pattern. The concentration is lower and the nests appear new as most of these still have eggs, and only a few have one or more chicks. This indicates that the peripheral parts of the islands have been exposed by the receding water during the last 20 days or so.

The nests of the river terns (*Sterna aurantia*) are found on the crust of algae and underwater weeds that has been exposed and dried up to form a one or two-inch layer on the underlying mud. The surface has deep cracks and fissures, and impressions of old human footprints. Many nests are on the open flat crust, or are mere depressions, while some are surrounded by dry underwater weed stems, grass or other vegetation found on the island itself. A few are surrounded by tiny shells, or fish bones which seem to serve no purpose and in fact attract attention to the nest. Occasionally nests were situated within depressions of old human footprints and in a few cases within the dried feeding grounds of flamingo. The eggs were very variable in colour — being buff with brown and green irregular splotches, to green with dark grey-green or brown splotches. A few eggs were mud covered and thus of a deeper brown shade. We observed chicks which were in the processes of hatching, upto a stage when they could run and swim strongly but were unable to fly. There were also several juveniles flying around. Nestlings often hid or kept away from the sun by sheltering under algal crusts that had been lifted up like a tent by the growth of new weeds under them.

The Pratincoles made themselves very obvious with their broken wing displays. Their nests were usually tiny cuplike depressions. In the grassy areas one side often had a screen of vegetation. These grasses seemed to have been purposefully loosely entwined. However, this may have been a pre-existing condition that made the birds choose the site. They had small light brown eggs with darker brown speckling. A few were darker at one end than the other with a sharp delineation between the two shades. There are still very few chicks, most of them being only newborn hatchlings.

Since many empty river tern nest sites were seen as evidenced by patches of excreta marks the colony must have been there for some time. The presence of juvenile river terns also shows that we are perhaps at the tail end of their nesting period, and in the middle of the nesting period of the Pratincoles on the islands.

We also found several nests with much smaller eggs that resembled those of the river terns. These may be those of the little terns that we also observed in the area. However, though we saw one of them approach the site of one of these nests, it was not seen incubating. This thus requires further follow-up.

There were also a few Kentish plovers and little ringed plovers on the island which may be nesting as well.

An interesting feature was the finding of three adult dead terns. This could be accounted for by predation by raptors such as the Osprey and Marsh harriers seen frequenting the area.

We found many footprints of otters on the island which may also account for the remnants of terns. Otters have been sighted off and on at Bhigwan and at times get caught in the fishermen's nets, when they are unfortunately killed by them.

With the water still receding, a problem is sure to occur unless the area is cordoned off. Within a short while both the islands will be linked to the shoreline of the lake. This will lead to an influx of cattle that will be attracted to the only patch of green in the area. Inevitably the nests will be trampled upon and destroyed. Village dogs will get access to the area and finish off eggs and chicks. Human intervention in the form of schoolboys, herdsmen, fishermen etc. will do the rest.

The access to the islands must thus be guarded in some way to prevent shortening of the present nesting season.

The disturbance should be kept to a minimum so that the birds will habitually set up a colony here year after year. We hope that the proposed bird sanctuary to be established at Bhigwan will speedily solve this problem.

'SAKEN' VALANTINA SOCIETY,
NORTH MAIN ROAD,
KOREGAON PARK,
PUNE 411 001,
MAHARASHTRA,
April 29, 1986.

E. K. BHARUCHA
P. P. GOGTE
T. P. GOLE

14. SIGHT RECORD OF STARLING *STERNUS VULGARIS* IN ANDHRA PRADESH

According to Ali & Ripley (1983) the winter distribution of Starling *Sturnus vulgaris* is in Pakistan and North India east to Bangladesh, south to Gujarat and Madhya Pradesh. Vagrants and stragglers are liable to be met in far-flung localities; thus two were recorded from Madras (Whistler, quoted by Ali & Ripley 1972). On 10.xii.1985, at 1715 hours outside the 800-hectare grassland plot maintained for the Great Indian Bustard, near Rollapadu village (15° 52′ N and 78° 18′ E), Nandikutkoor taluka, Kurnool district, Andhra Pradesh, a flock of eight Starlings was seen along with 8-10 Rosy Pastors (*Sturnus roseus*). Soon the two species flew off in different directions. The Rosy Pastors settled in another field but the Starlings were lost sight of. Though the Rosy Pastors were seen throughout the period of my stay at Rollapadu (10 days), Starlings were not seen again.

BOMBAY NATURAL HISTORY SOCIETY,
HORNBILL HOUSE,
SHAHEED BHAGAT SINGH ROAD,
BOMBAY 400 023,
May 24, 1986.

ASAD R. RAHMANI

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15. ON THE SINGING POSTURE OF THE STRONGFOOTED BUSH WARBLER (*CETTIA FORTIPES*)

Strongfooted Bush Warbler (*Cettia fortipes*) is very vocal in the breeding season, and in W. Himalayas its song is commonly heard in summer. But the extremely shy and retiring nature of this warbler makes it one of the hardest birds to observe. It is notorious for singing within a few feet of the observer without making itself visible; the ventriloquistic nature of the song further adds to the difficulty. Thus it is not surprising that the peculiar singing posture, which is described below, and its significance has not been recorded before.

On 29th May, 1985, in the Overa wildlife sanctuary, Kashmir at a height of 7500′, I came across a *Cettia fortipes* singing from a thicket. The bird was visible from the outside and was presumably unaware of my presence. I approached it very cautiously, moving only when it was singing and stopping every time it ceased singing. By this method I was able to reach within 10 feet of the bird. Through binoculars, minute details of its plumage were visible and also the orange coloured ring we had put on its leg a few days earlier. The singing bird was perched on a twig hunch-backed, with plumage slightly fluffed out, tail depressed and wings drooped. I watched the bird for about 35 song sequences and noticed no variation in the singing posture which is as follows: As it starts to sing the initial whistle, the body is slowly tilted forward to an angle of 45° to the perch, and by the time the whistle ends it has fully stretched itself forward. At the final outburst of notes, the head bobs furiously, the tail is jerked and it appears that each sequence is sung at its loudest. The song of the bird has been described as 'amazing', 'fascinating', etc. It is a long drawn ventriloquistic whistle followed by two rapid explosive notes, sometimes four. From my observations I found that there is extremely low degree of variation in the songs in one individual, as well as between other individuals of the species.

Much emphasis seems to be laid on the powerful song in the breeding biology of this species as this drab coloured warbler does not make itself conspicuous even while singing. Thus it seems very important that the male should execute its song perfectly and at its maximum vocal capacity; the above mentioned posture seems to have been evolved for that. It, therefore, does not seem to be any kind of display but essentially a body movement evolved to facilitate this peculiar kind of singing. There is strong selection against abberant and variable songs in such cases, as that may fail to attract a female. This may lead to distinctive songs and rigid postures. It is also very interesting to note that all the *Cettia* warblers are skulkers in habit and have developed songs peculiar to each species, which have high recognition value. A study to see whether all members of this genus have developed special postures for singing will be an interesting topic.

3 Rocky Hill,
Malabar Hill,
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November 23, 1985.

NITIN JAMDAR

16. SIGHTING OF THE WHITECAPPED BUNTING *EMBERIZA STEWARTI* (BLYTH) IN HINGOLGADH, GUJARAT

Recently, on a trip to Hingolgadh, a picturesque Fort Palace surrounded by scrub forest not far from Jasdan, we saw a solitary bunting feeding on a rocky slope and finally recognised the bird to be male Whitecapped Bunting, *Emberiza stewarti* (Blyth). But we found that it looked unlike that illustrated in the PICTORIAL GUIDE by Ali (1983). It had a white crown and the rest of the plumage looked quite dull, though the chestnut breast was quite conspicuous. Ali and Ripley (1982) in the HANDBOOK (compact volume) describe the white crown as a state where the grey feathers have abraded and that it occurs about the time of the spring migration. The present sighting was made on 14 February, 1986, so we presume that this bird was passing through on its return migration north.

To date, this species has been recorded only once before in Gujarat when it was seen in September, 1962 in the same area by Shivrajkumar (*J. Bombay nat. Hist. Soc. 59*: 956). The bird is a short-distance migrant, breeding in north Pakistan and the Himalayan foothills, and wintering in Punjab, Uttar Pradesh, Rajasthan and northeastern Maharashtra, according to the HANDBOOK.

P.S.: One male and two female birds were sighted again on 6 December, 1986. One female was also found dead, the specimen which has been presented to the BNHS collection.

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JASDAN 360 050,
GUJARAT.
DEPARTMENT OF BIOSCIENCES,
SAURASHTRA UNIVERSITY,
RAJKOT 360 005,
GUJARAT,
April 29, 1986.

SHIVRAJKUMAR KHACHAR

TAEJ MUNDKUR

17. BIRD CASUALTIES IN ROAD ACCIDENTS

I made a survey of the birds killed in road accidents for one complete year from May, 1980 to April, 1981 on National High Way 11 in Bharatpur district of Rajasthan for a length of 5 kms from Km stone 88 to 93.

The selected length of the road is a double way traffic route having an average width of 675 cms. On an average 11 vehicles per hour pass and were counted at Km stone 92 in May, 1980.

Almost every inch of the surrounding land is under cultivation of various crops. Many old trees of Tamarind (*Tamarindus indica*)

TABLE 1

CASUALTIES FROM DIFFERENT GROUPS

Group	No. of Casualties in one year	Special note
Amphibia	42	Only adults were recorded.
Reptilia	82	—
Birds	219	—
Mammals	96	Including domestic cattle but excluding human beings.
Total	439	

TABLE 2

BIRD CASUALTIES IN ROAD ACCIDENTS FROM MAY 1980—APRIL 1981

MONTH	*Bubulcus ibis*	*Pseudibis papillosa*	*Accipiter badius*	*Gyps bengalensis*	*Neophron percnopterus*	*Francolinus pondicerianus*	*Pavo cristatus*	*Grus antigone*	*Columba livia*	*Streptopelia decaocto*	*Psittacula krameri*	*Centropus sinensis*	*Athene brama*	*Merops orientalis*	*Coracias benghalensis*	*Upupa epops*	*Picoides mahrattensis*	*Dicrurus adsimilis*	*Acridotheres tristis*	*Corvus splendens*	*Pycnonotus cafer*	*Turdoides striatus*	*Orthotomus sutorius*	*Saxicola caprata*	*Saxicoloides fulicata*	*Passer domesticus*	Total
May 1980					1							1															2
June 1980				1						1													1				3
July 1980				1			2								1		1				1						6
Aug 1980				1			1			4	1				1				4	4		1					17
Sep 1980	3			4			1			9	3			1	1	3	1	1	3	12					1	1	44
Oct 1980	2	4		3		1	1	1	1	10	6			1					6	7					2	1	46
Nov 1980				2	1		4			4	4	1							3							1	20
Dec 1980					1		2			10										1		1				2	17
Jan 1981			1				1			8	1											1			1		13
Feb 1981				3	1		1			8	1	1		1					1	1		1				3	22
Mar 1981				2			2			6									2						1	4	17
Apr 1981				2		1				6			1											1		1	12
Total	5	4	1	19	4	2	15	1	1	66	16	3	1	3	3	3	2	1	19	25	1	4	1	1	5	13	219

are present on either side of the road. Younger trees of many species like *Eucalyptus* spp., *Acacia nilotica, Pongamia glabra, Dalbergia sissoo, Delonix regia* etc. which were planted by the Forest Department from 1977 to 1980 are also seen. The famous Keoladeo National Park, Bharatpur is hardly 35 km. away from this area.

During the study period a total of 439 casualties were recorded from different groups as shown in Table 1.

It is clear from Table 1 that the maximum casualties were among birds. The species-wise detail of the bird casualties is as follows (Table 2).

Peculiarities of the bird accidents:

1. Birds are the most susceptible for road accidents among vertebrates.
2. Birds remain active throughout the year hence they occur throughout the year in road accidents.
3. Aquatic birds keep away from roads and remain most of the time near or inside water bodies. Due to their restricted activities in vicinity of water bodies, a minimum number among them become victims of road accidents.
4. Nocturnal birds killed in road accidents were much less in comparison to diurnal birds.
5. *Streptopelia decaocto* has the highest number of casualties.
6. A very few *Gyps bengalensis* were nesting on old Tamarind trees present on either side of the road, and their mortality rate was high. Actually most of them were killed by moving vehicles while they were scavenging on dead bodies of other animals killed in road accidents.
7. A fair number of crows were also killed. Actually 90% casualties were among younger birds, born in that year, which were quite unfamiliar to roads due to lack of experience.
8. The maximum number of birds were killed during the rainy season, from July to October.

SATISH KUMAR SHARMA

FOREST RANGE OFFICER,
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RAJASTHAN,
April 17, 1986.

18. DEFENSIVE BEHAVIOUR IN THE INDIAN ROOFED TURTLE *KACHUGA TECTA* (GRAY)

(*With a text-figure*)

Static defensive adaptations — head, tail and appendage retraction into a shell, is seen in all emydid turtles. Box turtles of several genera from both the Old and New Worlds, in addition possess single or double hinges in the plastron, allowing them to cover, partially or completely, their retracted parts.

When alarmed, the Indian roofed turtle *Kachuga tecta* retracts its head, tail and appendages readily into its shell. However, in the absence of hinges in the plastron, the species is vulnerable to some degree of predation, especially from land-based predators, even after pulling in the projecting body parts into the shell. In this position, physical threat such as a light touch to the turtle's head or forelimbs makes the hindlimbs fully extended and planted vertically or obliquely to the substrate, while the head, tail and forelimbs are retained within the shell, thereby raising the posterior part of the shell considerably. In an 8.2 cm. (carapace length) specimen, the plastron was raised by 2 cm. Following adoption of the posture, the turtle may attempt to move forward, using its hind limbs, maintaining this unusual posture till suitable shelter is reached.

Evidently, the species assumes this defensive posture, as the head and forelimbs are given additional protection, being lowered close to the ground. Possibly turtles encountered by predators while wandering on land assume the posture, which gives some measure of protection to the exposed parts on the anterior opening of the shell, and may additionally confound some of the land-dwelling predators, thereby giving them several moments to proceed towards the relative safety of water.

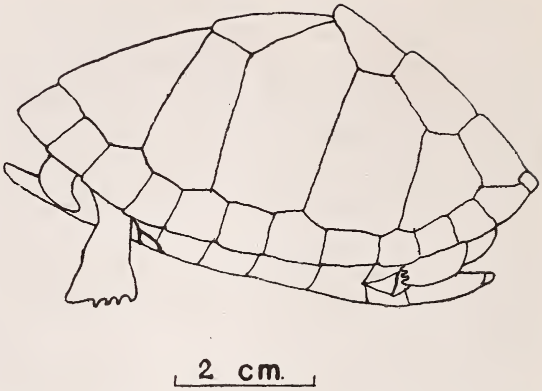

Fig. 1. Response of the Indian roofed turtle *Kachuga tecta* when physical contact is made to the retracted head and forelimbs.

18/20, Ballygunge Place (East),
Calcutta - 700 019,
April 23, 1986.

INDRANEIL DAS

19. AN INCIDENCE OF A GECKO (*HEMIDACTYLUS* SP.) FEEDING ON A SKINK

One evening in the last week of March, 1987, we were taking a stroll about a litter strewn portion of our garden in the midst of Madras city, when we heard some strange rustling noises from beneath a Laurel tree. On investigation, we witnessed a short struggle between a gecko and a skink. The gecko had grabbed the skink by the base of the tail, and for a few seconds, we saw the skink thrashing about frantically. The victim then shed its tail and made good its escape, leaving the tail-piece wriggling in the captor's jaws. The gecko quickly gobbled up the offered morsel of the tail-end and dissappeared into the litter.

The gecko was in all probability the tree gecko, *Hemidactylus leschenaulti,* which is a common dweller in the city gardens (Shekar Dattatri, pers. comm.). The skink appeared uniform dark brown all over with no stripes or markings, and was probably a sub-adult *Mabuya carinata.* Both predator and prey were about 5 inches in length.

There are two records of *H. leschenaulti* feeding on vertebrate prey. Sumithran (1982) observed the reptile feeding on a mouse, and later on, Dattatri (1984) reported a case of a *leschenaulti* predating on the sympatric

H. frenatus in a room in Madras City. But this could probably be the first reported case of a gecko feeding on a skink.

Our thanks are due to Messrs. J. C. Daniel, Rom Whitaker and Shekar Dattatri for their comments and suggestions on the observation.

33 Saravana Street,
Madras 600 017,
August 4, 1987.

R. KANNAN
R. KRISHNARAJ

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20. A NOTE ON THE FOOD HABIT OF THE GARDEN LIZARD, *CALOTES VERSICOLOR*

The garden lizard or blood sucker is mainly insectivorous in food habit and feeds on ants and insects which form a large proportion of the food. Other than insects, they occasionally feed on small birds, frogs and other small animals (Daniel 1983). There is one report by Daniel and Shull (1963) of *Calotes versicolor* eating unripe pods with soft seeds of the *Lima* bean.

On 18th October, 1986 at about 9 O'clock in the morning, during a visit to Sanjay Gandhi National Park, Bombay, I happened to observe a garden lizard feeding on the buds of *Tabarnae montana,* which is cultivated at the entrance of the park, Interestingly, after eating the buds the lizard tasted the petals of the flower partially. This observation lends support to the fact that vegetable matter also are occasional food items of the garden lizard.

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June 18, 1987.

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21. NOTE ON SNAKES FROM THE DISTRICT DANGS, GUJARAT STATE

During a wild life camp in the month of December 1987, I received a few snakes from Dangs district collected by Mr. Chandravir Jhala. The Dangs is a part of the Sahyadri ranges and is the most thickly forested area of Gujarat State.

I identified two species of snakes, namely *Uropeltis ellioti* (Gray) and *Ahaetulla pulverulentus* (Dum. & Bib.) which are recorded for the first time from the Dangs region. The details are as follow:

Uropeltis ellioti (Gray)

1 adult from Saputara village, Dangs. Collected in the first week of December, 1987. Total length 255 mm., tail 9 mm., V 157, C 6, Scale in row 17, Colour of the snake is dark brown with purple blue tint and small yellow spots on all over the body, yellow line on each sides of the neck, a yellow stripe on tail on both sides which form a transverse bar across the anal region.

Ahaetulla pulverulentus (Dum. & Bib.)

1 sub-adult from Pimpari village (30 km. from Waghai), Dangs collected in the first week of December. Total length 623 mm., tail 225 mm., V 194, C 175; 8 Supralabials, 5th below the eye, 4th having two subocular. Colour fawn-grey with interscale skin colour black and white forming oblique bars, lower jaw white, a dark brown stripe from the neck to tail on the middle of the belly.

Another from Dhuladhha village-680 mm long collected on 28th October, 1987 by Mr. Karmavir Bhatt.

According to Smith (F.B.I. Vol. 3) *U. ellioti* is found on the hills of Western Ghats, south of the Goa Gap to Tinnevelly, Eastern Ghats (Shevaroys, Coimbatore district, S. Arcot, Jalarpet, Visakhapatnam district, Ganjam), and *A. pulverulentus* is found in the Western Ghats (Karwar, N. Kanara, Nilgiris, Castle Rock, Nellampathy hills, Travancore).

The present record of the two species from Dangs district, Gujarat considerably extends their range.

Zoo Inspector,
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RAJU VYAS

22. PREDATION OF *MICROHYLA* TADPOLES BY *GAMBUSIA*

Embryos and tadpoles of the frog *Microhyla ornata* are being used in this laboratory to study the effects of pollutants and environmental factors on embryonic development. One of the authors (H.V.G.) has been collecting spawn of this frog from various localities in Pune since 1977. During 1986, two of the ponds that were known to be the sites where *Microhyla* brood were found to be devoid of any *Microhyla* eggs and tadpoles. These ponds contain water almost throughout the year due to groundwater streams. The ponds, however, contained tadpoles of *Rana* and *Bufo.* A survey of nearby places showed that adult *Microhyla* were present at these localities. A couple of spawns collected from another locality were then released in these ponds to see if there were any predators. It was observed that the eggs were rapidly consumed by *Gambusia affinis,* a fish which was presumably introduced to control mosquitoes and was present in large numbers. Later, tadpoles of various stages (newly hatched, 15 day-old, and hind-limb stage) were released to see if they survived predation. It was observed that none of the tadpoles could escape predation. Almost all of the released tadpoles were consumed by *Gambusia* within a few hours. This is in contrast with the observations of Rao (1917) who reported that *Microhyla* tadpoles escape predation due to offensive, acidic secretions of the cephalic glands. Rao further mentioned that fishes reject these tadpoles even if force-fed. Such secretions, if present, do not seem to repel *Gambusia.* Regarding the presence of *Bufo* and *Rana* tadpoles, it appears that many of these tadpoles escape predation because of their bottom feeding habits and comparatively active movements. Further, the number of eggs per spawn is quite large in both *Bufo* and *Rana,* a factor which helps to maintain population despite predation. *Microhyla* tadpoles are filter feeders and stay almost stationary at the surface of the water and thus fall easy prey to *Gambusia,* a fish that is very active at the surface.

Beebee (1984) also observed that toads freely breed in large ponds with fish. While discussing the success and failure of amphibians in garden ponds with fish, he further pointed out that presence of fish is not always catastrophic, and frogs do breed in ponds with fish; precise shape of the pond as well as the number of fish are probably crucial factors influencing tadpole survival.

Since most frogs, including *M. ornata,* breed in temporary rainwater pools there is little possibility of presence of large predatory fishes. Yet, when ponds with fish are chosen as breeding sites by *Microhyla,* the survival of eggs and tadpoles must be extremely low as compared with those of *Rana* and *Bufo.* The pond in question had only *Gambusia* and no other fish. It may be pointed out here that *Gambusia* has been reported to have adversely affected carp fisheries in reservoirs (Menon 1977). Thus it seems desirable that such fishes are not indiscriminately introduced in water bodies.

We are grateful to the authorities of Modern College for providing necessary facilities. Anand Padhye is thankful to U.G.C. New Delhi, for Junior Research Fellowship.

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June 17, 1987.

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23. ON A SMALL COLLECTION OF AMPHIBIANS FROM GOA

(*With a colour plate and a text-figure*)

To consider the northward extension of additional forms of the Indo-Malayan fauna from the south-west, HA had for many years wanted to visit Goa and the surrounding areas at the break of the monsoon when the amphibians and their tadpoles would be active and viable.

Dr. (Mrs.) Maria Jose Barboza, a regular bird-watcher at the Borivli Park, offered to help with some contacts there and a short trip was made in June, 1986. We flew to Dabolim in Goa, on 21st June, 1986 when we were taken to the Circuit House at Panjim, to meet AGS who had arrived by road earlier.

The next morning we were all driven down to the Bondla Sanctuary which encloses a large zoo, and spent the day there, driving eastward to Valpoi on the following day. That afternoon and evening we made some collections in the forest adjoining Kodal and walked to southern in the foothills.

Notes on the amphibians collected are listed hereunder:

1. **Bufo melanostictus** Schneider, 1799. Indian Toad.

1 ♀ Valpoi forest.

The toad was crossing a muddy forest road after a heavy shower, and its reddish brown colour blended with that of the road.

2. **Microhyla ornata** (Dumeril and Bibron, 1841). Ornate Microhylid.

2 ♂♂ Bondla.

This Microhylid was heard calling about 1815 hrs. from inside a pile of stones at the base of a tree. They were not visible. The call can be syllabilised as *trrk—trrk—trrk* and, though startlingly loud for an animal of this size, it was also ventriloquistic and made the location of the small frog sitting in the midst of grass or among stones extremely difficult to locate.

3. **Ramanella montana** (Jerdon, 1854). Jerdon's Ramanella.

9 (8 ♂♂, 1 ♀) Bondla.

Testes enlarged **c.** 4.3 × 2.2. Female with mature ova.

Heard calling in the afternoon at 1215 hrs from a ditch with some rainwater. They were calling when afloat with their snouts against the wall. The call which can be syllabilised as *brong...brong...brong* was heard in both rainy and cloudy weather. The species is very wary.

4. **Nyctibatrachus humayuni** Bhaduri and Kripalani, 1955. Humayun's Wrinkled Frog.

1 ♀ from Valpoi forest.

Ovary with mature pigmented ova. Collected from the base of a tree in open forest at about 9.30 p.m. after a heavy shower, about 15 yards from a flowing stream. The specimen differs from *N. major* in having fully webbed toes and with the disks on the fingers and toes very much larger and provided with a circum-marginal groove.

5. **Rana cyanophlyctis** Schneider, 1799. Indian Skipper Frog

6 (2 Bondla and 4 Valpoi)

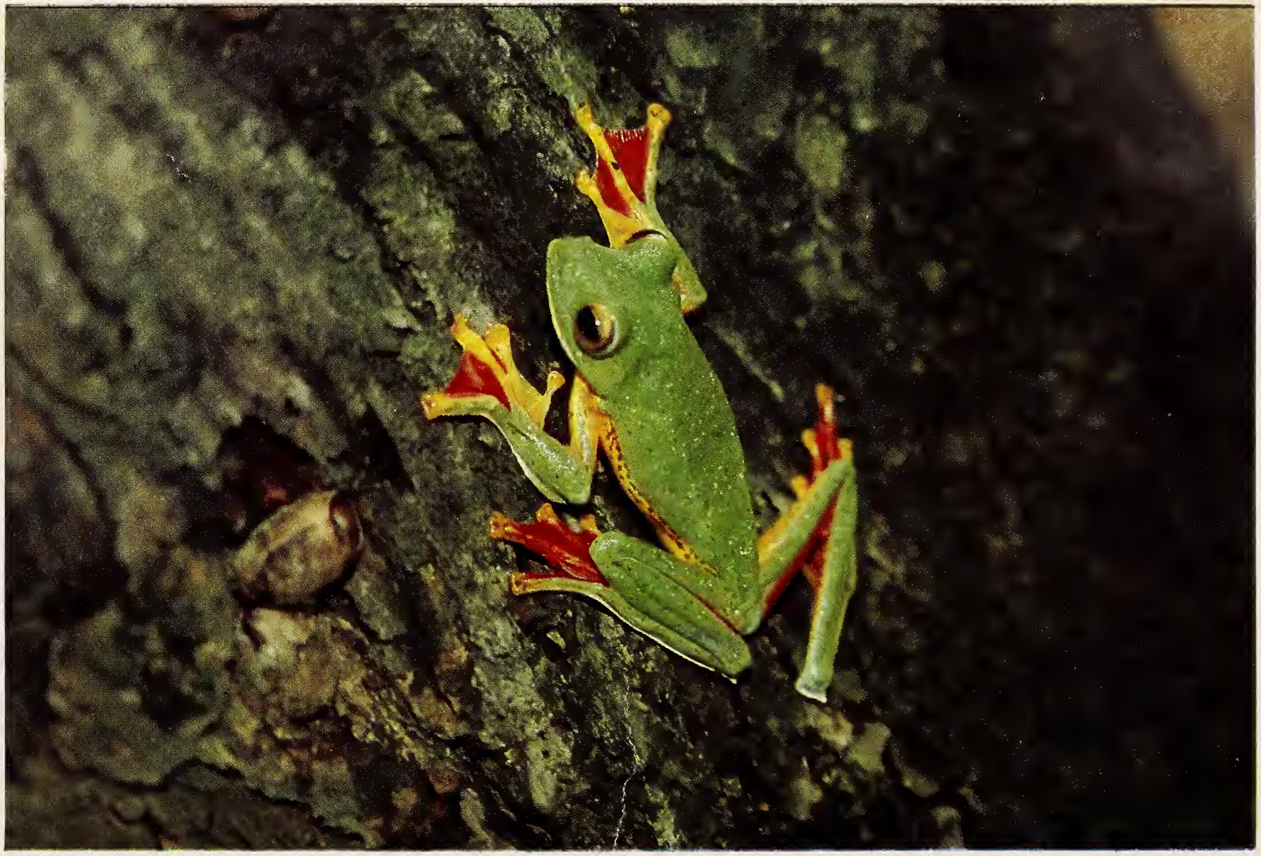
1 ♂ 5 ♀♀ (1 adult, 4 subadults).

Bondla specimens were collected from a tank and from a rainwater pool at Valpoi.

6. **Rana limnocharis** Boie, 1835. Indian Cricket Frog.

3 Bondla (2 ♂♂, 1 adult ♀)

Testes 1.9 × 1.4 mm. and 2×1.5 mm. Female with pigmented eggs. The frogs were



Malabar Flying Frog (*Rhacophorus malabaricus*) — The flying (gliding) frog.

collected near a muddy rain pool in the evening and kept in a bottle. An attempt to mate was made by a male even in this circumscribed condition.

7. **Tomopterna breviceps** (Schneider, 1799). Indian Burrowing Frog.

Syn. *Rana breviceps.*

1 ♂ Bondla.

Testes 5.5×2.5 mm right, 6×2.75 mm left.

Dead specimen collected from a tank at Bondla Sanctuary.

8. **Tomopterna rufescens** (Jerdon, 1854). Rufescent Burrowing Frog.

Syn. *Rana rufescens.*

6 specimens. Two (2 ♂) Bondla and four (1 ♂, 3 ♀) Valpoi.

9. **Philautus leucorhinus** (Lichtenstein and Martens, 1856)

5 ♂♂ Valpoi forest.

Testes around 2.6 × 1.6 mm.

The frogs were collected in the forest at 2030 hrs after a heavy shower and were located by their call which may be syllabilised as *treek...treek...treek* — with a gap of 4-6 seconds between them. They were sitting on tips of branches and in the forks of small trees. The single vocal sac, when calling, looked like a transparent bubble.

10. **Polypedates maculatus** (Gray, 1834). Common Tree Frog.

Syn. *Rhacophorus maculatus.*

1 ♂ Testes 5×3 mm.

Calling from a bush in the late evening. The call can be syllabilised as *tak...tak...tak...tak...*

11. **Rhacophorus malabaricus** Jerdon, 1879. Malabar Gliding Frog.

1 adult ♂ from Valpoi.

Testes 15×5 mm. The body was bright green and the tips of the toes and fingers yellow, with the webs between them red.

This is an extension of the known range of the species, as it has only been recorded as far north as Coorg in Karnataka.

While returning to camp in the dark it started to rain heavily and our attention was drawn to a loud and crackling *truk-truk-truk* from the forest some distance from the path. When followed up with torches we found some 30+ *Rhacophorus malabaricus,* either seated singly and calling, or *in copula* on leaves or branches overhanging 5′-15′, above the surface of a pool of rainwater about 30′ across. The amplexus is axillary. When disturbed, they jumped on to other branches at a lower level. The green of the frogs offset by the bright red of the broad webs between the fingers and the toes which were spread out when jumping/gliding was very impressive. With the five live specimens in Bombay we thought we would look at the process in greater detail. One was taken up the flight of stairs at Hornbill House and dropped off the railings vertically 23½ feet from the ground floor. Several persons were watching and there were loud expressions of wonder and surprise as the animal seemed to have expanded and glided down at a slight angle rather than fall. When about 2 feet from the bottom and 28 feet from the point of starting it suddenly turned upwards and having gained another foot or so, at about 4′ off the ground it landed against a vertical surface. This was repeated several times with very similar results, the animal never landing flat on the ground, and invariably turning upward when two or three feet off the floor and landing on a vertical surface (Fig. 1), once against a spectator's middle, after completing a journey of about 33′ in all through the air.[1]

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[1] M.O.P. Ayyangar (1915. Records of the Indian Museum: xi, pp. 140/142) refers to a slanting glide from a tree over a distance of 30 yards and also states that a whir was heard.

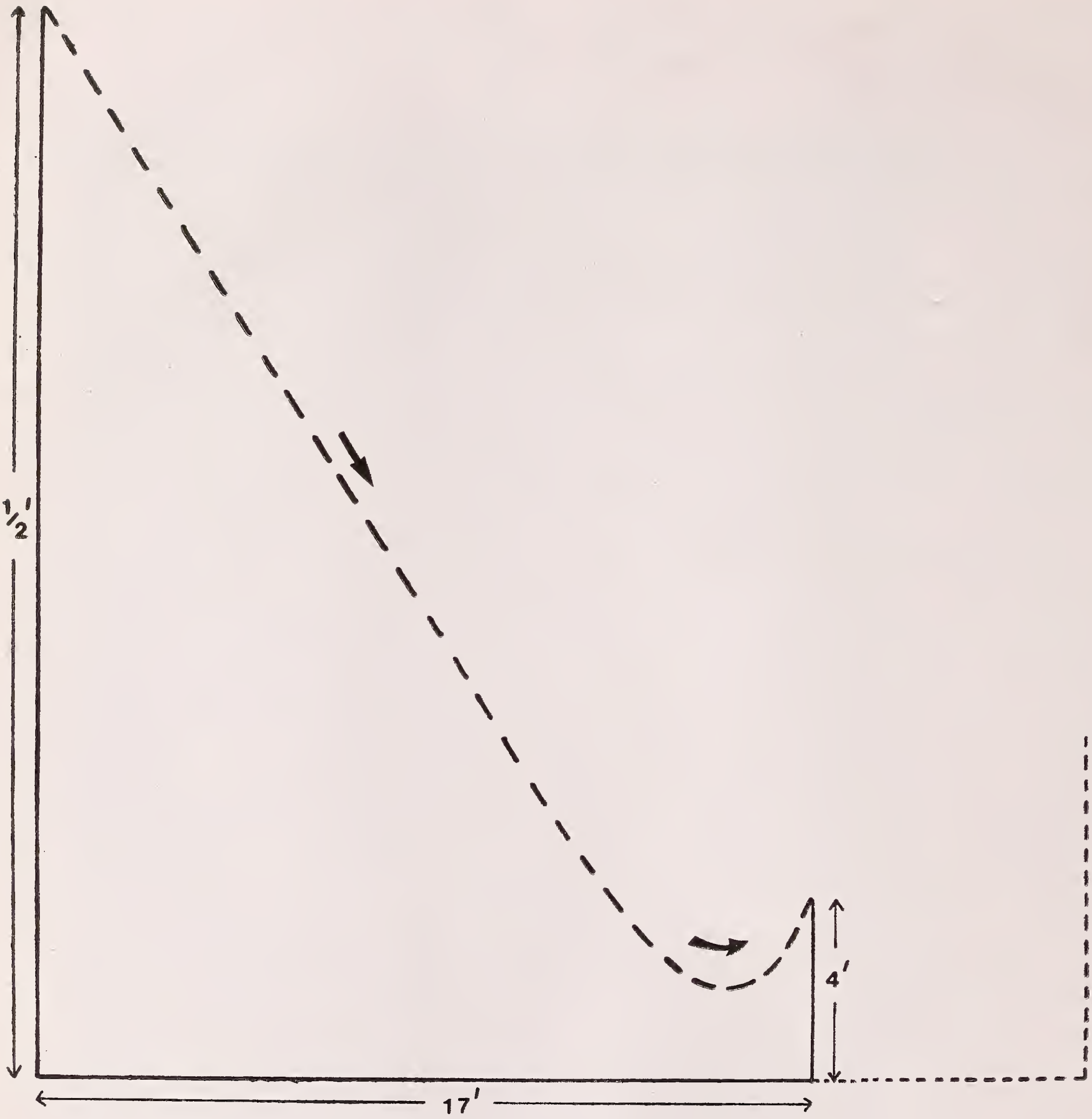

Fig. 1. The flying (gliding) path of *Rhacophorus malabaricus*.

We were unable to arrange for the animals to be photographed in flight but kept them hopefully for some time with Isaac Kehimkar, the BNHS librarian who lives in the suburbs. His notes read in part:

"I kept them in a glass aquarium (3 × 1 × 1 ft.) with moss as substratum, a few dead branches as props and a few plants (*Pothos scandens*). De-chlorinated water was sprayed once every two days to soak the moss below. The top of the aquarium was covered with glass sheets and nylon wire gauze.

"During the day the frogs usually rested on the leaves; either on the upper or under side, with their bodies gathered together yet flattened, the fore-feet folded underneath their bodies and pupils contracted to tiny slits. This posture and their leaf green colour rendered them almost invisible among the leaves, for I often had difficulty in locating them even when they were right in front. When disturbed, they would leap, flashing their bright red foot-webbings.

"Every day around 7.30 p.m. house flies (*Musca domestica*) were collected in plastic bags. A small lamp was placed outside the aquarium at one corner to attract the flies to one spot when released in the darkened aquarium. The frogs soon learnt to assemble around the lamp to pick up the flies, which were provided until a lop-sided bulge saying "enough" was noticed on the sides of the frogs. At the beginning whenever the flies were released the frogs would leap at them and flick them up with their tongues, but later they took them only when the flies came within reach. Earthworms were also offered but ignored. Also only a few blue-bottle flies (*Lucilia* sp.) were taken, being mostly ignored.

"I had these frogs with me for about two months, but one rainy night all escaped from a small gap which had remained uncovered when replacing the glass sheet. I heard them calling from adjoining Bougainville and guava trees for several nights, but was unable to trace them, for their call had a ventriloquistic quality."

The trip was much too short to make a representative collection but we hope to make another effort and do better. The cost of travelling to and from Goa was recovered from the Charles McCann Vertebrate Zoology Field Work Fund at the BNHS. All the arrangements in Goa were made by Mr. Louis P. Barbosa, Minister for Tourism and Urban Development and Mr. B. P. Sinha, Conservator of Forests, without whose assistance it would not have been possible to achieve even the little which we did. We would like to record our gratitude to the institutions and persons concerned for having made this trip possible.

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HUMAYUN ABDULALI

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A. G. SEKAR

24. MOUTH BROODING IN THE NOBLE GOURAMI, *CTENOPS NOBILIS* (MCCLELLAND) (PISCES: BELONTIDAE)

Some fishes display parental care in that, after fertilization, the eggs are held by one of the parents inside its mouth until they hatch and, sometimes, even thereafter. This can be commonly seen in the marine catfishes of the genus *Tachysurus* (earlier *Arius*).

There has been no record of mouth brooding in an Indian freshwater fish. *Sarotherodon* (=*Tilapia*) *mossambicus* females do have mouth brooding habits, but they are estuarine fish and are not indigenous to India, having been introduced into India from Africa, and which can live and even breed in fresh water.

One of us (S.R.S.) has been regularly obtaining live *Ctenops nobilis* (McClelland) from Bihar State. The fish are transported by rail in open cans, the journey taking some 46 hours. As the water in the cans may get warm during transport and oxygen in the water may be depleted, the fish undergo physiological stress. In several batches of *Ctenops nobilis* received between February and early May this year, we found many (from 60 to 100) dead fry. Enquiries with the supplier revealed that he had placed only adult *Ctenops nobilis* in the cans. The fry had obviously been spat out of the mouth by the adult fish. No other species of fish were transported in the can containing *Ctenops nobilis,* but as each can usually contains about 15 adults, we could not determine whether all the babies were spat out by one or many parents, and the sex of the parent doing mouth brooding.

On 29 April, 1987 two of the fish in the consignment showed considerably distended mouths. It was suspected that they might be brooding fry in their mouths. Each was separated in an aquarium. One of the fish, of 100 mm total length, spat out 103 fry, while the other, a smaller one, spat out 32 fry. The latter all soon died, together with the parent. The parent's mouth was seen to contain 15 parasitic worms, which might be the reason for the mortality. The age of the fry could not be ascertained. The brooding parent is a male. Unlike other mouth brooders, once the parent spits out its fry, it does not take further care of the young. Nor do the fry, at any sign of danger, swim back into or near the parent's mouth. Since we obtained brooding parents from February to early May, this indicates the extent of the fish's breeding season.

Ctenops nobilis has been recorded from Northeastern Bengal, Bihar, Assam and Sikkim in India, and from Bangladesh. It belongs to the family Belontidae. Indian members of this family include the Dwarf Gourami (*Colisa lalia*), Honey Gourami (*Colisa chuna*), Giant Gourami (*Colisa fasciata*), Thick-lipped Gourami (*Colisa labiosa*), and the Indian Paradise Fish (*Macropodus cupanus*). In all these, the male builds a nest of air bubbles, which are made sticky with its saliva. After fertilization, the male picks up the eggs, which are laid a few at a time, and spits them into the bubble-nest. After the female has completed laying eggs, she is vigorously chased away by the male, which guards the nest and keeps it from disintegrating by blowing more air bubbles on to it. There is, however, no mouth brooding in any of these fishes. Mouth brooding is suspected to occur in the Chocolate Gourami (*Sphaerichthys osphronemoides*) which comes from Malaysia and Indonesia.

SACHETAN,
L/4-5, SITARAM BUILDING,
PALTON ROAD, BOMBAY-400 001.

S. R. SANE

TARAPOREVALA AQUARIUM,
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B. F. CHHAPGAR

October 28, 1987.

25. ON THE SYSTEMATIC STATUS OF THE SPECIES OF THE GENUS *DANIO* HAMILTON DESCRIBED BY BARMAN (1983, 1984, 1985)

The systematic status of *Danio* (*Brachydanio*) *horai* Barman (Barman 1983), *Danio* (*Danio*) *assamensis* Barman (Barman 1984) and *Danio devario* (Barman 1985) has been assessed based on the study of types and general material of these species. It has been ascertained that *Danio* (*Brachydanio*) *horai* is a synonym of *Brachydanio acuticephala* Hora. The description of *Danio* (*Danio*) *assamensis* by the original author (Barman 1984) has been found to be faulty and the species is, therefore, redescribed here. The material identified as *Danio devario* Hamilton by Barman (1985) does not belong to this species and it is certainly a case of misidentification.

INTRODUCTION

During the course of a revisionary study of Rasborinae, an examination of the systematic position of the various species of the genus *Danio* Hamilton was attempted and we came to the conclusion that the status of the new taxa of this genus described by Barman (1983, 1984, 1985) was of doubtful nature. *Danio* (*Danio*) *menoni* (Barman 1985), is, in fact an already known species, *Chela laubuca* Hamilton of the subfamily Cultrinae and hence, not of Rasborinae (Tilak and Jain 1987). The systematic status of *Danio* (*Brachydanio*) *horai* Barman, *Danio* (*Danio*) *assamensis* Barman and *Danio devario* Hamilton in the publications of Barman (1983, 1984, 1985) has been assessed on the basis of the study of type material of the new species and general material of *D. devario* and the results are given in this paper.

DESCRIPTION

A. SYSTEMATIC STATUS OF *Danio* (*Brachydanio*) *horai* BARMAN

Barman (1983) described a new species, *Danio* (*Brachydanio*) *horai* from Arunachal Pradesh. The new species is characterized by the absence of barbels and lateral line. Barman (1983) has tried to compare this taxon with *Brachydanio nigrofasciatus, B. rerio* and *B. choprae* which possess one or more pairs of barbels and the lateral line is incomplete; this was done to establish the identity of the new taxon. Barman (1983) did not compare his material with *B. acuticephala.* The type material of *B. horai* Barman (ZSI, FF. 1827 and paratype No. FF. 1828) has been examined by us and it has been found that the material belongs to *B. acuticephala* Hora which was originally described from Manipur by Hora (1921). Hora (1921), while describing this species did not make a mention about the absence, of barbels or lateral line in this species but subsequently, Hora and Mukerji (1935), while describing the fishes of Naga Hills recorded this species from that area and corrected the earlier mistake in its description by making a definite statement that the barbels and lateral line are totally absent in this species. The type material of *B. horai* resembles *B. acuticephala* in all details. It should therefore, be a junior synonym of the latter.

B. acuticephala Hora is a species distributed in Brahmaputra and Chindwin drainage systems (Hora and Mukerji 1935) and the streams of Arunachal Pradesh form a part of this drainage system of Brahmaputra river. This species is expected to occur in Arunachal Pradesh. The distribution of *B. acuticephala* Hora, is therefore, extended from Manipur and Naga Hills to Arunachal Pradesh.

B. SYSTEMATIC STATUS AND REDESCRIPTION OF *Danio (Danio) assamensis* BARMAN

Barman (1984) described a new species, *Danio (Danio) assamensis* from Assam, India. The type material of *Danio assamensis* Barman (ZSI, Holotype FF. 1861 and Paratype No. FF. 1862) has been examined and it has been observed that the description given by the original author (Barman 1984) contains errors of observation. It is a valid species, hence the species needs a detailed redescription, which has been done here, by studying the holotype and 1 example of the paratype. Barman (1984) has not included many morphometric characters which are important for the study of interrelationship of this species with other species of the genus.

Description:

Danio assamensis Barman B. III, D. II/12, A. II/16-17, P. 12, V. 8, C. 21, Lat. 1. 36, Lat. tr. 7-1/2/2-1/2. Barbels 4, Predorsal scales 16.

Dorsal profile more or less convex and ventral profile bow-shaped. Head triangular, directed upward. Head length 3.75-3.93 and depth of body 2.66-2.72 in standard length. Width of head 1.93-1.94 and snout length 3.82-4.00 in length of head. Eyes anterior with 2 spines, one small backwardly projecting process at anterior rim of the orbit and the other pointing forward above the anterior superior margin of the orbit. Eye diameter 3.37-3.47 in head length and 1.05-1.15 in inter-orbital width.

Mouth small, directed upward. Barbels 2 pairs, rostral pair half the eye diameter and maxillary ones minute at the junction of upper and lower jaw.

Lateral line complete, with 2½ scales between it and origin of pelvic fin.

Height of dorsal fin 4.89-5.20 and height of anal fin 5.65-6.48 in standard length. Length of pectoral fin 4.55-4.89 and length of pelvic fin 6.19-7.06 in standard length. Pectoral and pelvic fins provided with scaly appendages.

Predorsal distance 1.68-1.78 and postdorsal distance 2.26-2.32 in standard length. Preventral distance 2.03-2.06 and postventral distance 1.71-1.87 in standard length. Preanal distance 1.23-1.42 and postanal distance 2.62-2.96 in standard length. Height of caudal peduncle 1.64-1.66 in its length.

Coloration:

Two pale longitudinal bands extending from the opercular end to the base of caudal fin on each side. A black spot at the superior margin of the gill opening present. Fins without any colour markings.

Remarks:

Barman (1984) measured the standard length erroneously (69 mm instead of 65 mm in holotype and 62 mm instead of 60 mm in paratype), overlooked a spine on the superior anterior margin of the orbit and counted the lateral line scales incorrectly, showing 40-41 scales instead of 36. Based on his observations, Barman (1984) adjusted *D. assamensis* in an identification key based on the orbital spine and lateral line scales. Since the type material of *D. assamensis* has only 36 scales in the lateral line, it cannot be separated from those species, which have 32-36 scales in lateral line. Hence, the identification key should also be revised in the light of the present observations. The main point of difference between *D. spinosus* and *D. assamensis* on the one hand, and the rest of the species of the genus *Danio* on the other, is the presence of two orbital spines. *D. assamensis* can be further separated from *D. spinosus* based on the lateral line scales which are 36 in the former and 52 in the latter.

C. SYSTEMATIC STATUS OF *Danio devario* HAMILTON EXAMINED BY BARMAN (1985)

While describing a new species, *Danio* (*Danio*) *menoni*, Barman (1985) wrote on *D. devario* that "Hamilton (1822) described *D. devario* from Indian waters without barbels, and subsequent workers like Day (1878) and Hora (1934) recorded this species with no barbels. During the course of my revisionary studies on the cyprinid genus *Danio*, out of hundreds of specimens of this species examined by me from different localities of India, not a single specimen was found without a pair of posterior or maxillary barbels." The observations recorded by Barman (1985) regarding the barbel in *D. devario* is very peculiar, because this species is never known to have barbels (Hamilton 1822, Day 1978, Hora 1934). During the course of study of fish fauna of various regions of the country, we have examined more than 200 specimens of *Danio devario* and find the barbels completely wanting in them. Tilak and Jain (1987) have already clarified the systematic position of *Danio* (*Danio*) *menoni* Barman which is, in fact, *Chela laubuca* of the subfamily Cultrinae. It is estimated, therefore, that the identification of *D. devario* of which hundreds of specimen have been examined by Barman (1985) is certainly wrong at the generic or subfamily level. The status of these specimens could be decided only if the material of *D. devario* studied by Barman (1985) is available for examination.

Since *D. devario* of Barman (1984, 1985) is based on misidentification, the adjustment of the species in the identification key given by him based on the presence of maxillary barbels, is faulty.

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ZOOLOGICAL SURVEY OF INDIA,
DEHRA DUN,
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26. FIRST RECORD OF THE KING-FISH, *SEMIPLOTUS MODESTUS* DAY, 1870 (PISCES: CYPRINIDAE) FROM INDIA

The cyprinid genus *Semiplotus* Bleeker, 1859 is represented by two species, *S. semiplotus* (McClelland 1839) and *S. modestus* Day (1870) from the Indian subcontinent. The former is known from India and Burma, and the latter was described and has been known so far only from Burma. Day (1878) gave the distribution of the species, as "Hill ranges near Akyab, Burma". During the study of a recent collection of fishes from Mizoram I identified two specimens of *S. modestus* Day (measuring 164 mm. and 196 mm.). This record from Mizoram, India, is the first record of the species from India.

A brief description of *S. modestus* Day is given here.

Semiplotus modestus Day, 1870

Semiplotus modestus Day, 1870, *Proc. zool. Soc.*, 101 (type-locality: hill ranges near Akyab, Burma).

Semiplotus modestus Day, *Fish. India.*: 550, pl. 133, fig. 1.

Material examined: 2 exs., 164 mm.-196 mm. TL. Reg. No. Zoological Survey of India, Calcutta FF 2605. Locality: Koladyne river, 20 km. east of Sangao, Mizoram, India. Coll. S. K. Chattopadhya and party. Date of collection: 3.2.1987.

DESCRIPTION

Head length 5.65 to 5.76 and body depth 2.92 to 3.09 in total length. Eye diameter 4.14 to 4.25 in head length, 2.14 to 2.50 in interorbital width. Snout broad, obtuse, length 3.40 to 3.62 in head length, overhanging the mouth with several pores on either side. Mouth inferior, transverse with a thin cartilaginous covering to the lower jaw. Lower jaw with a knob at the symphysis. Maxilla extending below the middle of the orbit. Barbels absent.

Fins: D. 24-25 (4/20-21), P. 15, V. 9 A. 10 (3/7), C. 19.

Dorsal fin inserted in advance of pelvic fin origin, nearer to tip of snout than to base of caudal fin and extending to above the anal fin, its last undivided ray osseous and serrated. Caudal fin forked, with the lower lobe slightly longer.

Scales: Lateral line scales 33 to 34, lateral transverse scales 11. $3\frac{1}{2}$ rows of scales between the lateral line and base of pelvic fins. Predorsal scales 14 to 15 and circumpeduncular scales 10.

Colour in alcohol: Body brownish, darkest in the upper half. Dorsal fin ray tipped black, pelvic and anal fin tipped with orange.

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27. OCCURRENCE OF A SCHIZOTHORACINE FISH (SNOW TROUT) IN A SUBTERRANEAN CAVE NEAR UDAIPUR, RAJASTHAN

Schizothoracine fishes inhabit hillstreams and lakes in the Himalayan and sub-Himalayan region extending to China (Day 1958). Jayaram (1981) gives their distribution as Kashmir, Punjab, Afghanistan, Pakistan, Tibet and Nepal.

One individual of this subfamily (Schizothoracinae) was caught in a subterranean cave having its entrance about 50 feet below the surface in the hilly terrain of Aravalli ranges near Udaipur (lat. 24°-34′ N; long. 74°-40′ E). The cave which had never been explored in the past is said to have been formed by copper mining activities in ancient times (around 3-4 thousand years back). The cave is dark and appears fairly wide in its spread with interconnecting channels. These channels are unapproachable, being very dark and at places too low in height. At the time of capture of the fish in May, 1987, the cave's water had a temperature of *c.* 18°C.

The fish was seen swimming near the entrance of the cave. It was caught and identified as belonging to the subfamily Schizothoracinae. The species could not be ascertained with the help of available literature as several characters of two genera *Schizothorax* Heckel and *Diptychus* Steindachner overlapped in the specimen. The description of the fish is as follows:

Body elongate, subcylindrical, abdomen rounded. Head large, rounded anteriorly, snout obtuse, smooth. Mouth inferior, crescentic, lower lip with papillated margin forming a reduced sucker (character of the genus *Schizothorax*). Eyes large, 6.7 in head length, laterally placed, barely visible from the ventral side. Total length 23.6 cm., standard length 18.8 cm; depth 3.9 in standard length and 4.81 in total length. Head 4 in standard length and 5.02 in total length. Only two barbels visible, maxillary in position, minute, less than the diameter of the eye. Dorsal fin inserted almost half ahead of pelvic fin, beginning above the posterior tip of pectoral fin. Dorsal fin 1+9, pectoral fin 17, pelvic fin 9 with a fleshy appendage in the axil (character of *Diptychus*), anal fin 7. The tile row of scales over the anal fin not much developed. Caudal forked 12+12, lateral line curved anteriorly ending in the middle of caudal fin. Lateral line scales 64 (unlike *Schizothorax* and *Diptychus*).

The occurrence of a Schizothoracine fish in the region south of Aravalli hills in Rajasthan is intriguing. Presently, there is no river or seasonal stream in this region connecting the drainage of the sub-Himalayan region of Punjab and Jammu-Kashmir. Since the cave does not receive any surface drainage, the presence of a Schizothoracine fish in the cave could be a case of geographical isolation. It is almost certain (Merh, personal communication) that the rivers and streams of western Rajasthan (Luni, Jojari, Bundi and others) had Himalayan connections in former days. There could also be an underground drainage of the sub-Himalayan watershed connecting the streams and rivers of the region south of Aravalli ranges. Obviously, the water of this drainage would be cold. Peculiar assemblage of different generic characters in the specimen studied could be the sequel of interbreeding and long isolation, thereby inducing speciation.

The water from the cave was pumped out for a few days by the mining department of Hindustan Zinc Ltd. for their use without our knowledge. It was then reported that several kilograms of fish were collected during this operation. This fish catch was allowed to be taken by the tribals residing nearby for their consumption. It is possible further specimens may not be available for confirmation of the above findings and further study. However, attempts are now being made to explore the cave further as it still contains water of shallow depth and thus may harbour ichthyologically interesting finds.

We are grateful to Prof. S. S. Merh, Dept. of Geology, M. S. University, Baroda for discussion.

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28. MATING AND OVIPOSITION BEHAVIOUR OF TEA MOSQUITO BUG *HELOPELTIS ANTONII* SIGNORET (HETEROPTERA: MIRIDAE)[1]

INTRODUCTION

The tea mosquito bug *Helopeltis antonii* Signoret (Heteroptera: Miridae) is the most serious pest of cashew *Anacardium occidentale* L. in India. The adults and nymphs of the pest feed on the sap of tender shoots, panicles and immature fruits resulting in their drying up. Though the biology of the pest is known, details of its mating and oviposition behaviour are not well documented except for the brief reports of Ambika and Abraham (1979) and Jeevaratnam and Rajapakse (1981). The mating and oviposition behaviour of *H. antonii*, observed mainly under laboratory conditions, is reported in detail in this communication.

MATERIAL AND METHODS

To observe the various sequences of mating events, male and female adult bugs were introduced in pairs into glass chimney cages and tender shoots of cashew were provided as food material. For studies on oviposition, mated females were maintained in separate cages with tender cashew shoots that were changed daily and also examined for the eggs laid. These studies were carried out in the laboratory under a mean temperature range of 27.8-33.4°C and a relative humidity of 56-73%. Observations were also carried out in the field at the cashew plantations of Central Plantation Crops Research Institute at Vittal.

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RESULTS AND DISCUSSION

MATING BEHAVIOUR

1. *Arousal*: The mating process is always initiated by the male. Sexual identification is mainly by visual stimuli and occurs when a female comes in the close vicinity of a male. Once the male comes in contact with a female the following sequence of activity occurs in rapid succession. The male becomes alert and appears to be visibly agitated as seen by its movements. The male begins to probe lightly over the entire body surface of the female with its antenna; this phase of antennal contact lasts for a very short period (10-30 sec.) and probably serves to physically stimulate the female. A receptive female's response to the male's activity is passive, whereas a non-receptive female moves away quickly from the male. Thus, courtship is brief and not elaborate.

2. *Mounting*: The male then mounts the female generally from the posterior region. The rostrum of the male is erect and it appears to stroke lightly over the dorsal region of the female just below the thoracic shield. The stroking activity of the male probably has a quietening effect on the female for insertion of the aedeagus. During this phase, which is also brief (25-60 sec.) the male bends the tip of its abdomen towards that of the female. The aedeagus is then extruded and kept erect and is observed to make thrusting movements for the insertion of the same into the genital aperture of the female. In certain cases when the female did not appear to admit the aedeagus, the male moved it side to side across the genital area of the female until insertion was achieved. In certain cases females attempted to dislodge males by vigorous kicking and shaking movements. Dislodged males immediately attempt to mount again and in some cases insertion of the aedeagus is achieved in the second or third attempt.

3. *Copulation*: As soon as the aedeagus enters the genital chamber of the female the male twists around and copulation occurs in an 'end to end' position. Copulatory pairs remain stationary and exhibit very little body movements unless disturbed and do not feed. Copulation lasts for a mean period of 51 min. (n = 15; range: 27-81 min.). Jeevaratnam and Rajapakse (1981) have mentioned that mating pairs remain *in copula* for 10 min.-2 h.

4. *Termination of copulation*: The disengagement of the copulatory pair is rather abrupt. Both sexes struggle for a short period (30-50 sec.) before succeeding in doing so. With the termination of mating, they move away to a short distance and begin to feed immediately; sometimes they also clean their antennae, appendages and genitalia. Females that have just mated do not respond to attempts of other males to mate with them.

The mating behaviour was similar under laboratory and field conditions. Mating was observed to occur throughout the day, both in the laboratory and in the field. In the field when the temperature is high, mating pairs have been observed under leaves and other similar shaded situations. The role of sex attractant pheromones in the attraction and recognition of the sexes in the field cannot be ruled out. Smith (1977) has demonstrated the presence of a sex attractant pheromone in adult females of *H. clavifer*, a pest of cacao in Papua New Guinea.

OVIPOSITION BEHAVIOUR

The eggs are inserted into the tissues of tender stems and inflorescence stalks as reported by Ambika and Abraham (1979) and Jeevaratnam and Rajapakse (1981). On the latter they are generally oviposited on the main rachis and rarely on the secondary rachis. In some cases, eggs are laid in the mid-rib of leaves especially in the ventral region, and also in the petioles. The eggs are laid either singly or in groups of 2-4. An examination of 500 sample eggs showed that 43.6 per cent of them were laid singly. When the eggs are deposited in groups they occur in a single row or in two rows. Egg laying occurs mainly during the night but has also been observed during the day.

Just prior to oviposition the female probes the plant tissues for a suitable site with the tip of its rostrum. As soon as a suitable site is selected the female bends its abdomen and extends the ovipositor so as to establish contact with the plant tissue. The tarsi of all the pairs of legs firmly grip the substratum. The ovipositor is then inserted into the plant tissue and the abdomen is observed to distend and contract until an egg is deposited at an angle below the epidermis in the parenchymatous tissue. The ovipositor is then soon withdrawn. During the process of oviposition the antennae are held forward and slightly bent. The site of oviposition is difficult to trace immediately after it is completed; however, a browning of the region occurs in 1-2 days. A pair of silvery white chorionic processes of the egg which are unequal in length protrude outside the plant tissue and can be easily recognised with the aid of a magnifying glass.

The mean duration of preoviposition and period in the present study was 3.6 days (n = 15; range: 3-5 days) and 7.4 days (n = 15; range: 5-10 days) respectively. The mean number of eggs laid by a female was 48.1 (n = 15; range: 24-71 eggs). The pattern of oviposition in relation to duration of oviposition period is given in Table 1. More than 75 per cent of the eggs were laid during the first half of the oviposition period.

TABLE 1

PATTERN OF OVIPOSITION IN *Helopeltis antonii*

Day of oviposition	No. of eggs laid per female*
1	7.9
2	7.5
3	7.7
4	7.3
5	6.3
6	4.5
7	3.7
8	1.9
9	0.8
10	0.3

* Values indicate mean of 15 replications.

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29. YOUNG LAC INSECTS IN A MINIATURE ANT'S NEST

Many insects live underground and so do most species of ants. A typical case would be of the common black ant, *Camponotus compressus.* On the contrary there are insects which build their nests in elevated areas or on tree tops. Such an insect would be the honey-bee. Then there is an ant which builds its nest on trees, and it is *Oecophyla smaragdina.* Prof. Doflein, who was Professor of Zoology, Freiburg University, Germany, before the First World War, as Zoologist, toured over Southern Asia, visiting Ceylon as well. Here he observed the ant *Oecophyla smaragdina* building its nest. Living on a tree with broad leaves, some ants tried to hold them close to one another while others glued them together with the secretion of their larvae otherwise destined to become silk-like thread for their cocoons when dried. Thus arose a nest formed of leaves with the size almost two-thirds of an ordinary football. Doflein was the first to illustrate such a nest and also to show the ants bringing separated leaves near each other for being woven into a nest. A subject of my study had been lac. While at Bangalore, I found that the local species, *Kerria mysorensis,* grows best on *Shorea talura.* This has broad leaves of the same size as that of the banyan. Besides the lac insect there was the ant *O. smaragdina.* It had constructed nests, some around the stems on which lac insects were found. Then there were other nests of which the leaves on the undersurface were infested with some scale-insects. Lac insect is also a scale-insect so that the inhabitants of the ants' nests were all scale-insects. They secrete honey-dew which serves as the food of the ant. Thus in effect the ants' nest was like a dairy. There was also evidence to show that ants helped to transplant scale-insects on leaves and increase their number in the nest. The scale-insects then were treated like cows by the ants. As far as I remember Doflein does not mention whether the ants' nest which he observed was populated with scale-insects.

However, like the Asian species *O. smaragdina,* there is one in Africa named *O. longinoda.* E. O. Wilson, the American authority on ants, and Hoelldobler & Wilson (1981) have studied the African ant, which was rehabilitated in a greenhouse in America. Their illustrations confirm the main observations of Doflein. They do mention that the ants "gather the sweet honey dew, the excrement of scale insects". But there is no hint to the effect that the nest was found populated by scale-insects and it functioned like their dairy. This is because their observations refer to a rehabilitated ant colony and not the natural one in Africa.

Whereas the large nests of the two ants *Oecophyla smaragdina* and *O. longinoda* have been illustrated, a similar nest of a small ant remains unrecorded. Lac was cultivated in a small plantation near the village, Dorsanipalia, on the way to Banergatta in Bangalore. The tree was called "Jalari" in Kanarese, which would be *Shorea talura*. The insect was a new species which has been named *Kerria mysorensis*. It gives three crops of lac per thirteen lunar months. In the above area I found the nest of a small ant. The nest was built of spores and residues of fungi growing on the leaves of *Shorea talura* infected with lac. The insects excrete honey-dew copiously and much of it falls on the leaves below where saprophytic fungi grow profusely upon it. The predominant fungus was *Aspergillus niger*. This accounted for the black appearance of the miniature ant's nest, shown almost natural size. The ant had so constructed the nest that there was one hole which was used as entrance and the other as exit. I was able to find another nest of the same ant in its earliest stage of construction. A portion of a twig was colonized by young lac insects soon after they had fixed themselves. Finding that there was a small colony of lac insects the ants came to construct a nest using the saprophytic fungi as the building material. The motive of constructing the nest was the same as of the larger nest by the weaver ants *O. smaragdina* and *O. longinoda*.

The species that built the nests, could not be ascertained, as, unfortunately this information was contained in a file which I had taken to Pabna, Bangladesh, and which was subsequently lost. Its nest is fully formed with two holes, as entrance and as exit, which suffice to speak of the ants' intelligence. The nest was also constructed in order to be sure of supply of honey-dew.

SUMMARY

Ants build nests to exploit scale-insects as a constant supply of honey-dew, as do two species of *Oecophyla*, Asiatic and African. A miniature ants' nest has been found covering a colony of young lac insects also as source of honew-dew.

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30. RECORD OF *SIMA ALABORANUS* (WALKER), A HONEYDEW SCAVENGER ANT (HYMENOPTERA: FORMICIDAE: MYRMECINAE) KILLING APHIDOPHAGOUS SYRPHID MAGGOT IN WESTERN HIMALAYA

In nature, there exists a symbiotic association between plant lice and attending ants (Nixon 1951, Bodenheimer and Swirski 1957, Way 1963, Bradley and Hinks 1968) where the latter, to some extent provide protection to the aphid colony from predators (Bank 1959) and get nourished with sugar excreta of the aphids. The experiments of El-Ziady and Kennedy (1956) indicated that *Aphis fabae* Scopoli multiplies more rapidly when attended by *Lasius niger* L. whether the aphid's enemies are present or not. Ants have never been found to kill aphid predators, although Capinera and Roltsch (1981) observed that they might prey upon lepidopterous pests of the same plants where aphids are also pests and are attended by the same ant species.

During our present investigation on aphids and related organisms of Garhwal range of western Himalaya, *Sima alaboranus* (Walker), a high altitude ant species distributed in western India and Bengal (Bingham 1903) was found in association with *Prociphilus* sp. (Homoptera: Aphididae) causing leaf galls on honeysuckle, *Lonicera quinquelocularis.* These ants, due to their peculiar foraging habit, collect semisolid honeydew droplets discharged by the aphids and carry them to their nests following a trail. The relationship is facultative as ants are attracted only with the dehiscence of the gall and subsequent exposure of honeydew droplets already stored inside the gall. This is the probable reason for such type of ephemeral association being observed only during early summer (April-May). *Prociphilus* sp. on its secondary host, in the pine root, was observed to be attended by *Acanthomyops latipes* Walsh in Manitoba (Bradley and Hinks 1968). Catherine *et al.* (1977) found *Prociphilus* sp. in the nest of *Lasius pallitarsis* (Provancher). However, there is no specificity of such association and it rather depends on the availability of ant nests in the vicinity of aphid infestation. Bradley and Hinks (1968) distinguished two categories of ants, viz., a true aphid attendant, and a honeydew scavenger, foraging in the territory but actively avoiding contact with the attendant species of ants. But in our observation on honeysuckle leaf gall aphid, we never got a true aphid attendant species of ant.

S. alaboranus shows a strong aggressive behaviour towards the predatory syrphid maggot, *Episyrphus balteatus* (de Geer) (Diptera), the major limiting factor of aphids in general and leaf gall inhabiting aphid in particular in the area. Due to the sluggish nature of syrphid maggots, the ants have little trouble in attacking them, whereas other predatory species like coccinellids, anthocorids, spiders etc. being speedy and agile can easily escape from the attack of ants. The ants carrying syrphid maggots were traced during the summers of 1984 and 1985 and it was seen that after getting down to the ground they drop them. We picked up a few of the dropped maggots and found that they were nearly dead and had a few punctures on their body. We tried to feed a few of these maggots with prey aphids or water soaked cotton (often syrphid maggots can thrive on plain water up to 7 days), but they refused to accept any food and gradually succumbed to the injuries. This observation is interesting since *S. alaboranus* attacks aphid predators, the predatory efficiency naturally decreased to keep the pest population below damaging level.

ACKNOWLEDGEMENTS

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31. DUNG AND DUNG BEETLES IN KANHA TIGER RESERVE, CENTRAL INDIAN HIGHLANDS

During zoological fieldwork in Kanha Tiger Reserve, Mandla District, Madhya Pradesh, dung beetles were collected from the faeces of a variety of mammals. As data on dung beetles in Kanha have not been previously published the results are presented here.

Kanha Tiger Reserve is a 1945 km^2 tract of dry deciduous, moist deciduous (sal, *Shorea robusta*) forest and anthropogenic meadow in the Maikal Hills (Schaller 1967, Newton 1984, 1985). It holds abundant large mammals including tiger (*Panthera tigris*) and ten species of ungulate. Dung beetles were collected (1980-1982) from dung deposited on and around the central Kanha maidan (80° 38′ 3″ E, 22° 17′ 15″ N, 600 m above m.s.l.) immediately east of Kanha Forest Village in sal forest and meadow. The identity of the dung was determined by PNN and Mungal Baiga, and the beetles by Mr. L. Jessop of the British Museum (Natural History), London.

The species of coprophagous beetle collected and the identity of the mammal responsible for the dung are listed in Table 1. All beetles belong to the subfamily Scarabaeinae. In addition, an *Anomala* species (Rutelinae) was collected from elephant dung (*Elephas maximus*). A total of 22 species of Scarabaeinae were collected with one species of *Garreta* (near *G. smaragdifer* Walker) apparently undescribed (Jessop, pers. comm.). Of the 29 collections of the large genus *Onthophagus*, *O. griseosetosus* could be identified, while the remaining specimens were sorted into nine "Recognizable Taxonomic Units" which are probably separate species.

Dung beetles were collected in February, March and May to August with the peak in frequency of collection in the monsoon months of June and July. With the exception of two species collected from chital (*Cervus axis*) rumen contents at a dhole (*Cuon alpinus*) kill, the few beetles collected outside the monsoon were at elephant faeces. The apparent specialization on elephant dung and rumen contents by beetles foraging outside the monsoon may reflect the large size, softness and presence of a persistent humid core in both these resources.

Kingston (1977), in a study of the coprophagous beetle fauna of elephant (*Loxodonta africana*) dung in Kenya, also found very few beetles outside the wet season. The fauna was richer (126 species collected in 2 years) than that collected in Kanha, although comparison is complicated by the considerably greater effort expended in the Kenyan study. Coe (1979) collected 21 species of Scarabaeinae from cow dung in 7 days in south India with 2 species (*C. repertus* & *G. cyaneus*) common to this study.

Most studies of dung beetles have examined their relationship with the dung of one mammal species, such as the cow (Hanski & Koskela 1977, Coe 1979) or elephant (Kingston 1977). Few investigations have examined the selection of dung of various mammal species by different coprophagous beetles. Eight of the 22 species collected were only found on one "species" of dung (Table 1). *Onthophagus griseosetosus* was found at the greatest number of dung "species" (5), but the remaining members of the genus were confined to elephant and wild pig (*Sus scrofa*) dung. Most other species did not colonise elephant dung but exploited chital and langur (*Presbytis entellus*) faeces, with occasional records on blackbuck (*Antilope cervicapra*), elephant, jackal (*Canis aureus*), dhole and human faeces. K. K. Gurung collected dung beetles from tiger, Indian elephant and Indian rhinoceros (*Rhinoceros unicornis*) in the Royal Chitwan National Park, Nepal (material in BM (NH), pers. comm. L. Jessop). Three species were common to this collection. *Paragymnopleurus sinuatus* & *Zizyphus crispatus* were found on rhinoceros dung while *Catharsius molossus* was found on elephant faeces. Of the 30 species collected, 18 belonged to the genus *Onthophagus.*

TABLE 1

NUMBER OF OCCURRENCES OF DUNG BEETLES AT 56 FAECES OF 8 MAMMAL SPECIES IN KANHA TIGER RESERVE

Scarabaeinae beetle species	Mammal Species (responsible for dung)									
	Chital	Blackbuck	Pig	Elephant	Jackal	Dhole	Langur	Human	N	n
Catharsius molossus L.							1		1	1
C. pithecius Fabricius	1	2			1		1		5	4
Onitis subopacus Arrow	1+								1	1
Copris ?davisoni Waterhouse	1+								1	1
C. carinicus Gillet							1		1	1
C. repertus Walk.									*1	0
Gymnopleurus cyaneus Fabricius	1	1					1		3	3
Paragymnopleurus sinuatus Olivier							3		3	1
Garreta mundus Wiedmann	1								1	1
Garreta sp. [undescribed]							3		3	1
Zizyphus crispatus Gory	3			1		1	3		8	4
Proagoderus pactolus Fabricius							1	1	2	2
Phalops olivaceus Lansberge	1								1	1
Onthophagus griseosetosus Arrow	2	1		3	1		5		12	5
Onthophagus: nine species			3	14					17	2

+ = collected from rumen contents.
* = collected at night while flying into light.
N = number of collections in which species identified.
n = number of mammal species' dung at which beetle species recorded.
For mammals, latin names see text.

Euryphagy was the predominant pattern in Kanha with few stenophagous species. A similar pattern was reported by Halffter & Mathews (1966) for tropical Africa. Although the sample sizes are small, two Kanha species, *P. sinuatus* & *Garreta* (undescribed) appeared to be confined to langur dung. Similarly, Struhsaker (1975) suggested that, in Uganda, the beetle *Gymnopleurus crenulatus* is associated with red colobus (*Colobus badius*) dung. Factors involved in dung selection may include fibre size and concentration (e.g. in elephant faeces) and chemical composition. However, there is no clear distinction between beetles utilizing herbivore and carnivore dung in Kanha.

The interpretation of these results is complicated by collector bias. The large number of beetles collected from langur dung relative to other mammals probably reflects the fact that langurs were being intensively studied. Similarly, the collection of only one species of Scarabaeinae from dhole dung probably reflects the rarity with which dung positively attributable to this species, as opposed to jackals, was identified. The three mammals which supported the greatest species richness of dung beetles — chital, elephant and langur produced the most visible and abundant dung. Additional confounding factors include the possible under-representation of nocturnal beetles (Coe 1979) and beetles which visited dung briefly and rolled balls of faeces away (Kingston 1977), in comparison to diurnal beetles and those which remained within dung. The lack of data on the number of individuals of each species at each dung deposit limits the usefulness of the collection. If 'switching' (Kingston 1977) occurred, with beetles becoming more specialist with the onset of breeding, the pattern illustrated in Table 1 will depend on the reproductive state of the beetles during the collection periods.

The fieldwork was permitted and assisted by the Jt. Sec.. Wildlife (Dept. of Forests & Wildlife, New Delhi), Chief Wildlife Warden (M.P.) and the Field Director, Project Tiger, Kanha. PNN is greatly indebted to the Kanha staff of the Madhya Pradesh Forest Department and to Mungal & Mohan Baiga for their assistance. We are greatly indebted to Mr. L. Jessop of the British Museum for the identification of the beetles and for comments on this note. The fieldwork was carried out whilst PNN was in receipt of a SRC (UK) studentship.

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32. THE INDIAN FRITILLARY (*ARGYREUS HYPERBIUS* L.) IN THE CHAMBAL AREA OF MADHYA PRADESH AND RAJASTHAN (LEPIDOPTERA: NYMPHALIDAE)

INTRODUCTION

The Indian Fritillary (*Argyreus hyperbius* Linné) is the only member of its genus, which is closely allied to the genus *Argynnis* and its close relatives, all of which are purely Palaearctic. It has a solid distribution from the western Himalaya to China and Japan. Though mainly linked to temperate zone habitats, the species breeds at lower levels than members of related genera.

Contrary to related genera (except for a few members of the genus *Issoria* in highland East Africa) *A. hyperbius* is present in the montane areas of the tropical zone. In India it is found on the highest mountains of South India, at Pachmarhi in Madhya Pradesh, on Mt. Abu in Rajasthan and Sri Lanka. It is found in the highlands of Malaysia where, according to Eliot (1978), it has recently established itself in habitats modified by man, but it is common in highland Sumatra. It is also found in montane New Guinea and in Queensland, Australia. This type of distribution of a Palaearctic species is highly unusual in itself, but the presence of a distinct subspecies also in the highlands of Ethiopia makes the butterfly, I think, biogeographically unique. Each of the geographical isolates have been described as separate subspecies, but they are not very distinct from each other.

LOW LEVEL OBSERVATIONS OF *A. hyperbius*

Despite its Palaearctic origins and its essentially temperate habitat choice, there are scattered records of this butterfly from the plains: Delhi, Lucknow, Bombay, Saurashtra, and near Patna. In April, 1985 I collected a small series in the Himalayan foothills near Ramnagar, U.P. Most of the plains specimens have been taken during the winter months, and the general impression is that they move down to the plains in autumn instead of hibernating in the mountains. This is the case for a small group of Palaearctic butterflies described by Larsen (1986). The normal food plant for the species and its related genera is *Viola,* and the weed *Viola tricolor* is found in gardens and fields on the plains. There is one record from the plains during the summer months. I collected several specimens of both sexes in Jor Bagh Colony, New Delhi, in July, 1961, descendants of those recorded by Bent Bogh Andersen in March of the same year. It must be emphasised, however, that the total number of low level observations of this butterfly are few.

OBSERVATIONS ON THE CHAMBAL

On 22.xii.1985 I stopped briefly in the ravines of the Chambal River, where the main Gwalior-Agra road crosses the river. I saw at least six males of *A. hyperbius* and resolved to plan my return journey is such a way as to look further into the matter. On 27.xii.1985 I checked the ravines to a depth of 500 m on either side of the river. The butterfly was everywhere plentiful, and several specimens were met with that had limp wings, indicating that they had only just hatched. They were definitely breeding, but only in the dacoit infested ravines. Spot checks in agricultural-lands nearby yielded no specimens. The only previous record that I have traced of low level breeding is that of de Rhé Philippe (1902) who found larvae on potted violets and *Lobelia* in Lucknow. The latter is not normally used by the genus or its relatives. There were no likely food plant candidates in the Chambal area.

The Chambal habitat, to my mind, is a most surprising one for the species. The ravines have summer temperatures in excess of 45° Centigrade, are very dry, and contain a basically xerophillous vegetation dominated by *Capparis aphylla*. Thousands of *Anaphaeis aurota* F. were hatching in the area at the time. All other butterflies present were typical of arid tropical lands in Asia, and in some cases also Africa. The presence of *A. argyreus* in large numbers was highly anomalous. But there they were, and they must have had an alternative, unrecorded food plant.

Discussion

A. hyperbius definitely cannot permanently survive on the plains of India, and the July records from Delhi in 1961 must be exceptional. A revisit to the locality on 1.iv.1986 yielded no specimens. Confirmation of this was found in the Nilgiri Mountains of South India where I reared some 100 pupae in Kotagiri (1900 m) with very little mortality. Of the pupae obtained, eighty hatched in Kotagiri without incident, while most of twenty hatching at Mettupalayam on the plains were crippled, apparently because temperatures reached very high levels at the time.

The ability of *A. hyperbius* to breed at low altitudes during cool weather is probably a factor in its wide distribution in the montane zones of the Asian tropics. More information on its migrations and survival on the plains would be of great interest.

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33. REVISED NOMENCLATURE FOR SOME BUTTERFLIES OF THE INDIAN REGION

Subsequent to my contributions on the nomenclature of Indian butterflies (Varshney 1980, 1985), two significant publications from the British Museum (Nat. Hist.) have appeared, which have changed the names of butterflies in two families considerably. These changes involve a number of species occurring in the Indian region. Hence this note is put up to update our information on these taxa.

Family DANAIDAE

Ackery & Vane-Wright (1984) have revised the world fauna of milkweed butterflies (Subfamily Danainae). On the one hand they have resurrected many names from the synonymy, and on the other proposed several new taxa. I tend to agree with their statement, "Although homonymy, synonymy and misidentification have all played a part in this chequered history, the last category, the creation or recognition of false groups, has had the most undesirable effects."

All species recorded from different parts of the Indian region, under their present names, are listed below. The taxa are arranged alphabetically, and the distribution is shown alongside, restricted to Indian region only. The number in square brackets on left side, refers to the Sl. No. of that species in the Table 1 of my earlier paper in this *Journal* (Varshney 1980: 34).

Subfamily DANAINAE

Tribe DANAINI

1. *Danaus* (*Anosia*) *chrysippus* (Linn.) — Sri Lanka; NW., NE. and S. India, Andaman & Nicobar Is., Nepal and Burma.
2. *D.* (*Salatura*) *affinis* (Fabr.) — India: Nicobar Is.
3. [9] *D.* (*S.*) *genutia* (Cramer) — Sri Lanka; NW., NE. and S. India, Andaman & Nicobar Is.; Nepal and Burma.
4. [10] *D.* (*S.*) *melanippus* (Cramer) — India: Nicobar Is.; Burma.
5. *Ideopsis juventa* (Cramer) — India: Nicobar Is.
6. *I. similis* (Linn.) — Sri Lanka; Burma.
7. *I. vulgaris* (Butler) — Burma.
8. [4] *Parantica aglea* (Stoll) — Sri Lanka; N.W., N.E. and S. India, Andaman Is.; Nepal and Burma.
9. *P. agleoides* (Felder & Felder) — N E. India and Nicobar Is.; Burma.
10. *P. aspasia* (Fabr.) — Burma.
11. *P. melaneus* (Cramer) — Nepal; NE. India; and Burma.
12. *P. nilgiriensis* (Moore) — S. India.
13. *P. pedonga* Fujioka — Nepal and NE. India.
14. [5] *P. sita* (Kollar) — NW. and NE. India; Nepal; Burma.
15. [6] *P. taprobana* (Felder & Felder) — Sri Lanka.
16. *Tirumala gautama* (Moore) — India: Nicobar Is.; Burma.
17. [7] *T. limniace* (Cramer) — Sri Lanka; NW., NE. and S. India, Andaman & Nicobar Is.; Nepal and Burma.
18. *T. septentrionis* (Butler) — Sri Lanka; NW., NE. and S. India; Nepal and Burma.

Tribe EUPLOEINI

19. [17] *Euploea algea* (Godart) — Nepal; NE. India; Burma.
20. *E. camaralzeman* Butler — Burma.
21. [15] *E. core* (Cramer) — Sri Lanka; NW., NE. and S. India, Andaman & Nicobar Is.; Nepal and Burma.
22. [12] *E. crameri* Lucas — NE. India and Nicobar Is.; Burma.
23. [11] *E. doubledayi* Felder & Felder — NE. India and Burma.
24. *E. eunice* (Godart) — India: Nicobar Is.; and Burma.
25. *E. eyndhovii* Felder & Felder — Burma.
26. [14, 20] *E. klugii* Moore — Sri Lanka; NE. and S. India; Burma.
27. *E. midamus* (Linn.) — NE. India and Andaman Is.; Burma.
28. *E. modesta* Butler — Burma.
29. *E. mulciber* (Cramer) — NW., NE. and S. India; Nepal; Burma.
30. [16] *E. phaenareta* (Schaller) — Sri Lanka and Burma.
31. *E. radamanthus* (Fabr.) — Nepal; NE. India and Burma.

32. [13, 18] *E. sylvester* (Fabr.) — Sri Lanka; NE. and S. India; Burma.
33. *E. tulliolus* (Fabr.) — Burma.
34. *Idea agamarschana* (Felder & Felder) — India: NE. India and Andaman Is.; and Burma.
35. *I. hypermnestra* (Westwood) — Burma.
36. *I. iasonia* (Westwood) — Sri Lanka.
37. *I. leuconoe* Erichson — Burma.
38. [2] *I. lynceus* (Drury) — Burma.
39. *I. malabarica* (Moore) — S. India.

Family LYCAENIDAE

Eliot & Kawazoe (1983) have revised the world fauna of *Lycaenopsis* group of species, which are now treated under the Subfamily Lycaeninae, Tribe Polyommatini. They have proposed numerous new combinations. The Indian taxa, earlier dealt under *Lycaenopsis* or *Celastrina,* have now been put in 12 genera. Therefore, a portion of the Table 6 (from Sl. Nos. 30 to 50) in my paper dealing with this family (Varshney 1985: 314-15) requires to be altered. I have alphabetically listed below all species and subspecies recorded from the Indian region by Eliot & Kawazoe (l.c.). The distributional range within Indian region is shown alongside. The Sl. No. in brackets given on left, refers to the table 6 of my above cited paper, and shows the species covered in the book by Wynter-Blyth (1957).

Subfamily LYCAENINAE

Tribe POLYOMMATINI

1. *Acytolepis lilacea indochinensis* Eliot & Kawazoe — Burma: Pegu Yomas.
2. [31] *A. lilacea lilacea* (Hampson) — S. India: upto Nilgiris.
3. [31] *A. lilacea moorei* (Toxopeus) — Sri Lanka.
4. *A. puspa cyanescens* (de Niceville) — India: Nicobar Is.
5. [30] *A. puspa felderi* Toxopeus — Sri Lanka; S. India: up to Bombay.
6. [30] *A. puspa gisca* (Fruhstorfer) — Pakistan; N. India and Andaman Is.; Bangladesh; Burma.
7. *A. puspa lambi* (Distant) — S. Burma: Victoria Point.
8. *A. puspa prominens* (de Niceville) — India: S. Nicobar Is.
9. *Callenya lenya lenya* (Evans) — S. Burma.
10. [48, 49] *C. malaena malaena* (Doherty) — India: Manipur; Burma.
11. [45, 46] *Celastrina argiolus jynteana* (de Niceville) — Along S. Himalayas: Nepal; NE. India; Burma. Also see note below.
12. [44] *C. argiolus kollari* (Westwood) — W. Himalayas: Pakistan (Chitral) to India (Kumaon).
13. [43] *C. gigas* (Hemming) — W. Himalayas; W. Nepal.
14. *C. hersilia vipia* Cantlie & Norman — E. Nepal; India: Sikkim and NE. India.
15. [42] *C. huegelii huegelii* (Moore) — India: W. Himalayas upto Naini Tal.
16. [42] *C. huegelii oreoides* (Evans) — Nepal; India: E. Himalayas.
17. [41] *C. lavendularis lavendularis* (Moore) — Sri Lanka; SW. and S. India.
18. [41] *C. lavendularis limbata* (Moore) — N. India; Burma.
19. *C. morsheadi morsheadi* (Evans) — India: Upper Brahmaputra basin.
20. *C. oreas oreana* (Swinhoe) — NE. India: Khasi & Jyntia Hills.
21. *C. oreas yunnana* Eliot & Kawazoe — Burma.
22. [36] *Celatoxia albidisca* (Moore) — Hills of S. India.
23. [37] *C. marginata marginata* (de Niceville) — C. Himalayas: India (Sikkim, NE. India) to Burma (Karen Hills).

24. [38] *Lestranicus transpectus* (Moore) — NE. India; Bangladesh; Burma.
25. *Lycaenopsis haraldus renonga* Riley — S. Burma: Mergui.
26. *Megisba malaya presbyter* Fruhstorfer — India: Andaman Is.
27. *M. malaya sikkima* Moore — N. India, NE. Himalayas.
28. *M. malaya thwaitesi* Moore — Sri Lanka; India: Sikkim, Orissa, S. India up to Bombay.
29. [40] *Monodontides (M.) musina musinoides* (Swinhoe) — NE. India; Burma.
30. *Neopithecops zalmora andamanus* Eliot & Kawazoe — India: Andaman & Nicobar Is.
31. *N. zalmora dharma* (Moore) — Sri Lanka; S. India upto Nilgiris.
32. *N. zalmora zalmora* (Butler) — India: Kashmir to Bengal, Assam and Orissa; Bangladesh and Burma.
33. [50] *Notarthrinus binghami* Chapman — NE. India; N. Burma.
34. *Oreolyce (Arletta) vardhana nepalica* (Forster) — Central and E. Nepal.
35. [32] *O. (A.) vardhana vardhana* (Moore) — Pakistan; India: NW. Himalayas (Kashmir to Naini Tal).
36. [47] *O. (O.) dohertyi* (Tytler) — India: Nagaland.
37. *Plautella cossaea pambui* (Eliot) — S. Burma.
38. [33] *Udara (Penudara) albocaerulea albocaerulea* (Moore) — C. Himalayas: India and Nepal; and Burma.
39. *U. (Selmanix) selma cerima* (Corbet) — NE. India; Burma.
40. [35] *U. (U.) akasa mavisa* (Fruhstorfer) — S. India; Sri Lanka.
41. *U. (U.) cyma cyma* (Toxopeus) — S. Burma.
42. [39] *U. (U.) dilecta dilecta* (Moore) — Pakistan; N. India and Burma.
43. [34] *U. (U.) lanka* (Moore) — Sri Lanka.
44. *U. (U.) placidula howarthi* (Cantlie & Norman) — NE. India: Assam, Manipur; and Burma.
45. *U. (U.) singalensis* (R. Felder) — Sri Lanka and S. India.

NOTES

A correction may be made in my Table 5A (*JBNHS 82*: 310), *'Magisba'* should be read as *'Megisba'*.

Eliot & Kawazoe (1983: 217) have changed the well known name *Celastrina jynteana* Moore to *C. argiolus iynteana* (de N.). They state, "The original spelling was *iynteana* both in the text and in the plate. Subsequently de Niceville (1890: 104) altered the spelling to *jynteana*, presumably because Moore had in the meantime introduced that spelling, and this has been copied by all subsequent authors." The change is unfortunate. The species was named after its habitat: the Jyntea Hills (Meghalaya, India). Its original citation *'iynteana'* was a misspelling. De Niceville (1890) and all subsequent workers have correctly used the name *jynteana*, which is restored here under the Article 32 (d) of the International Code of Zoological Nomenclature (1985, 3rd edition).

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Thanks are recorded to the Director, Zoological Survey of India, for providing facilities and encouragement.

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34. SOME OBSERVATIONS ON THE MOTHER - YOUNG RELATIONSHIP IN *MESOBUTHUS TAMULUS TAMULUS* (FABR.) (ORDER: SCORPIONIDA, FAMILY: BUTHIDAE)

(*With two text-figures*)

INTRODUCTION

This study describes 9 month's observations on commonly occurring yellow scorpion, *Mesobuthus tamulus tamulus* (Fabr.) in Maharashtra. It is well known that the mother carries the young on her back. As they grow in size, after 8-10 days after birth, the larvae get scattered from the mother and gradually maternal care behaviour diminishes in intensity.

MATERIAL AND METHODS

14 gravid females were collected from Pirangut Wagholi and Kamshet around Pune. They were kept in a wooden cage of size 1′ H × 1½′ L × 1′ W (Fig. 1) with wire mesh on 3 sides and a glass door. The legs of the cage were kept in plastic containers holding water to keep out ants. Black soil was spread and pieces of coconut shell were placed in the cage. Insects were given as food and water was given twice a week.

After parturition, each mother along with its young was separated and kept in a glass jar with a cover of muslin cloth.

OBSERVATIONS

After delivery, the mother carried a litter of 20-25 tiny white young, measuring 10 mm in length, under a thin white birth membrane on her back (Fig. 2). Occasionally they moved but otherwise were quiescent. During this phase, the mother hungrily devoured 2-3 prey offered, one by one. However her movements were restricted and she attempted to catch a prey only when it was within her range. The tail constantly covered the young and the mother alertly responded to minute stimuli. The fingers of pedipalps were open. The ventral surface of the body touched the ground but the posterior portion of the mesosoma was slightly uplifted. The legs were spread and the back arched; when the young scorpions crawled over her legs and pedipalps, the mother remained motionless.

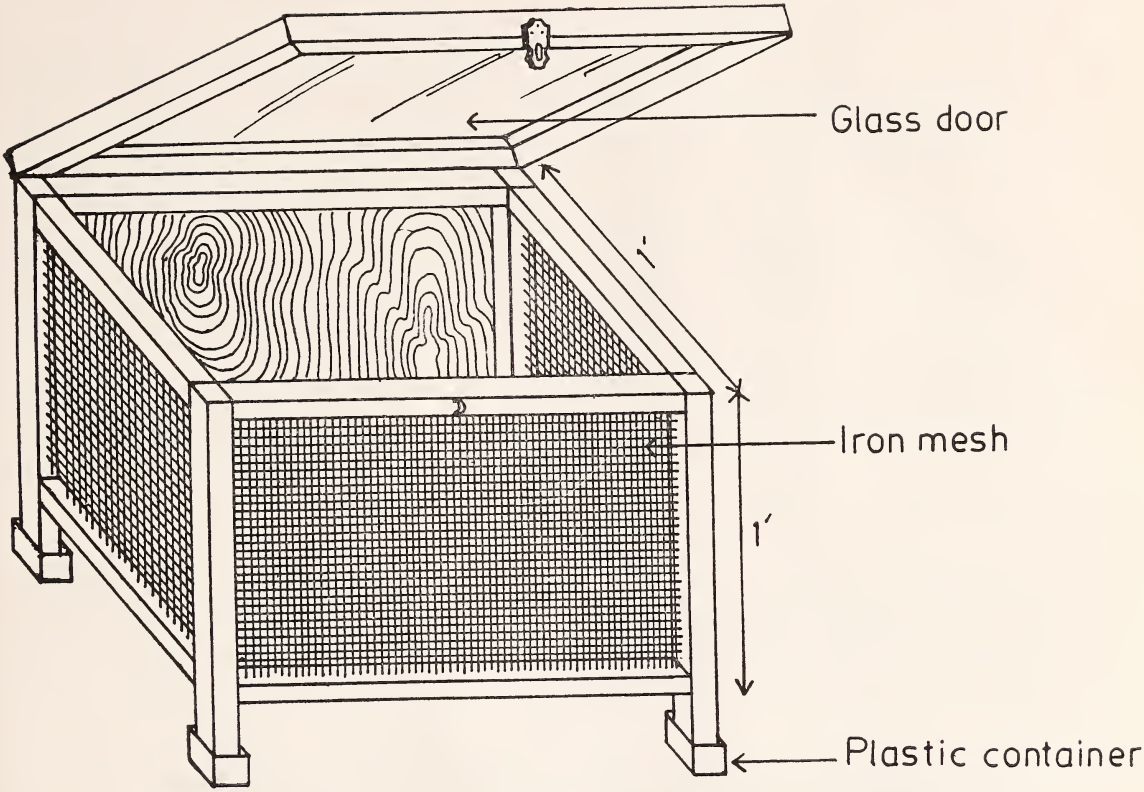

Fig. 1. Scorpion cage.

After 3 to 4 days, the young moved actively and hid below the belly of the mother.

One of the females gave birth to young ones during day time. She stood with tips of both pedipalps touching the ground. The metasoma and telson was straight and, thus the female stood arched and the young were dropped to the ground.

The young were able to recognize the parent and crawled over her body. Ten days after birth the young left the mother scorpion, wandered around and were seen hiding below coconut shell but at the slight stimulus of a brush, they swiftly rushed towards the mother.

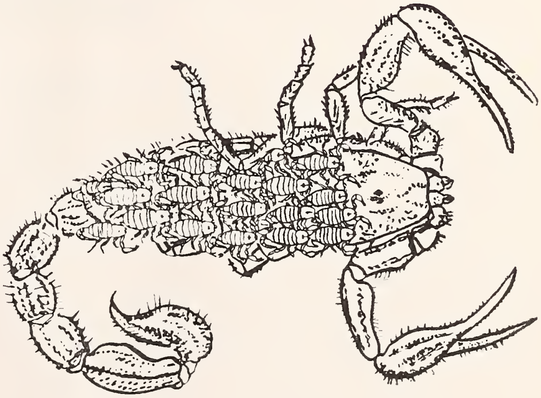

Fig. 2. Mother with larvae on her back.

TABLE 1

THE BIRTH RECORD OF YOUNG

Mother	Date of parturition	Time of parturition	Number of young
A	13-10-1980	Night	25
B	12-11-1980	Night	20
C	11-2-1981	Day	21
D	19-2-1981	Night	15
E	24-2-1981	Night	30
F	24-2-1981	Night	20
G	26-2-1981	Night	24
H	31-3-1981	Day	40
I	23-4-1981	Night	20
J	26-6-1981	Night	27
K	15-11-1984	Day	29
L	14-3-1985	Night	20
M	17-3-1985	Day	14
N	15-5-1985	Night	14

DISCUSSION

Observations on *Mesobuthus tamulus tamulus* (Fabr.) suggest that the mother offers perfect protection to the young which recognize their mother. Rarely a mother scorpion ate young, but it was perhaps the result of captivity and lack of food.

ACKNOWLEDGEMENTS

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35. ON AN INTERESTING CASE OF PARENTAL CARE AND DISTRIBUTION OF *CORMOCEPHALUS DENTIPES* POCOCK (CHILOPODA: SCOLOPENDROMORPHA: SCOLOPENDRIDAE)

Cormocephalus dentipes Pocock is a scolopendrid centipede, earlier recorded from Assam, Bengal and surrounding areas (Jangi and Das 1980). Subsequently, its distribution in the western Himalaya (U.P.) and Himachal Pradesh (Khanna and Kumar 1984) indicated that the species under study is not thoroughly collected or studied in the gangetic plains including Terai regions of Uttar Pradesh. Recently, we have been able to collect a good number of *Cormocephalus dentipes* Pocock from the subsoil and under-forest leaf-litter among sal trees in Terai zone of Uttar Pradesh in Dudhwa National Park. The occurrence of this species in Dudhwa National Park extends its range of distribution to the intervening region between the north-western and eastern parts of India. It seems probable that the species might be available throughout, if a thorough search is made.

So far no mention of its breeding behaviour or egg cluster has been reported by earlier workers. During the faunistic survey on 23rd July, 1986, a female specimen was collected from decaying leaves near the Forest Rest House, Belraiyan (Dudhwa National Park). At the time of collection, the same female was observed exhibiting an interesting behaviour of parental care towards its eggs. The female held the ball-like clutch of 32 eggs tucked under the ventral side of the body by its abdominal appendages. When disturbed, the female coiled itself around the cluster of eggs. After a careful manipulation, when the egg cluster was detached and kept at a distance of about 4-6 inches away from the female, it immediately desperately searched for its egg cluster and coiled around the egg cluster with the help of mouth parts and prothoracic appendages and quickly moved back into the loose soil. The burrowing of the female into the loose soil was facilitated by to-and-fro movements of the prothoracic and thoracic appendages.

The size of individual egg is nearly 2 mm in diameter. The egg is ovoid and yellowish due to the presence of heavy yolk surrounded by transparent thin follicular layer.

We thank the Director, Zoological Survey of India, Calcutta for encouragement and facilities.

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36. CLADOCERA OF KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN. II. NEW RECORDS 1. *MOINODAPHNIA MACLEAYII* (KING, 1853) AND 2. *BOSMINOPSIS DEITERSI* RICHARD, 1895

(*With two text-figures*)

Keoladeo National Park has a considerable range of fresh water habitats (Lat. 27° 7.6′ N, Long. 77° 29.5′ E). About ten percent of the land is covered with water, which is a converted marsh (artificial). The sanctuary receives water from Ajanbund reservoir (man-made) only during rainy season and the reservoir receives and retains faunal elements (both zooplankton, insects and fishes) from Gambir and Banganga rivers. Freshwater micro-crustaceans as well as Rotifera are among the commonest zooplankton of Keoladeo National Park (Ali and Vijayan 1983). The only papers dealing with Rajasthan freshwater zooplankton are those of Biswas 1964, Nayar 1965, 1968, 1971 and Mahajan *et al.* 1980. At present, the species composition, ecology and production of freshwater zooplankton of the Keoladeo National Park is poorly known, though the sanctuary attracts aquatic birds from various parts of the world. Hence a survey was made during July, 1984 to May, 1985 to study the occurrence of crustacean zooplankton in and around the sanctuary. The present note deals

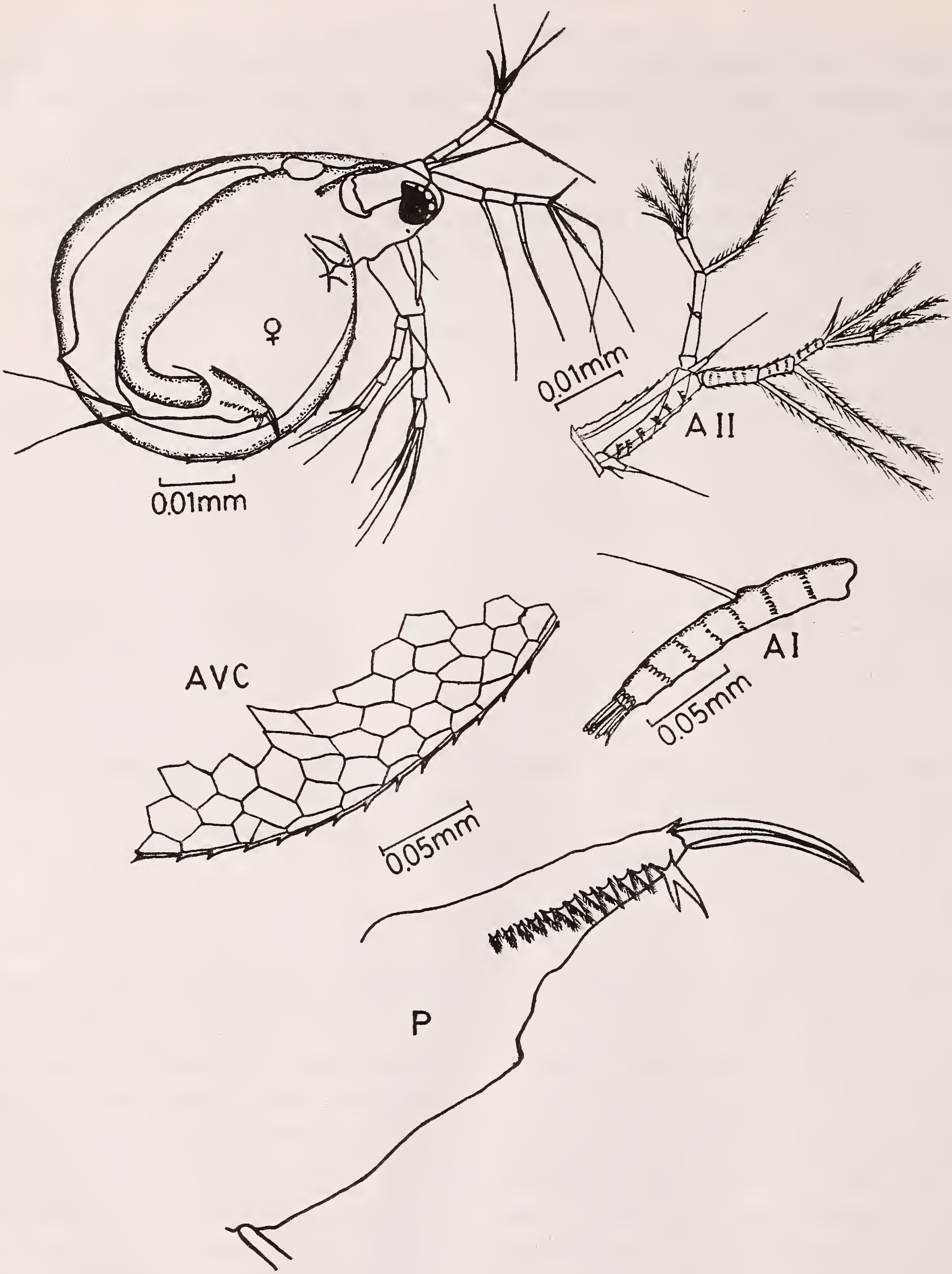
♀
0.01mm
0.01mm
A II
A I
0.05mm
AVC
0.05mm
P

Fig. 1. *Moinodaphnia macleayii,* Female: AI — antennule; AII — antenna; AVC — ventral margin; P — postabdomen

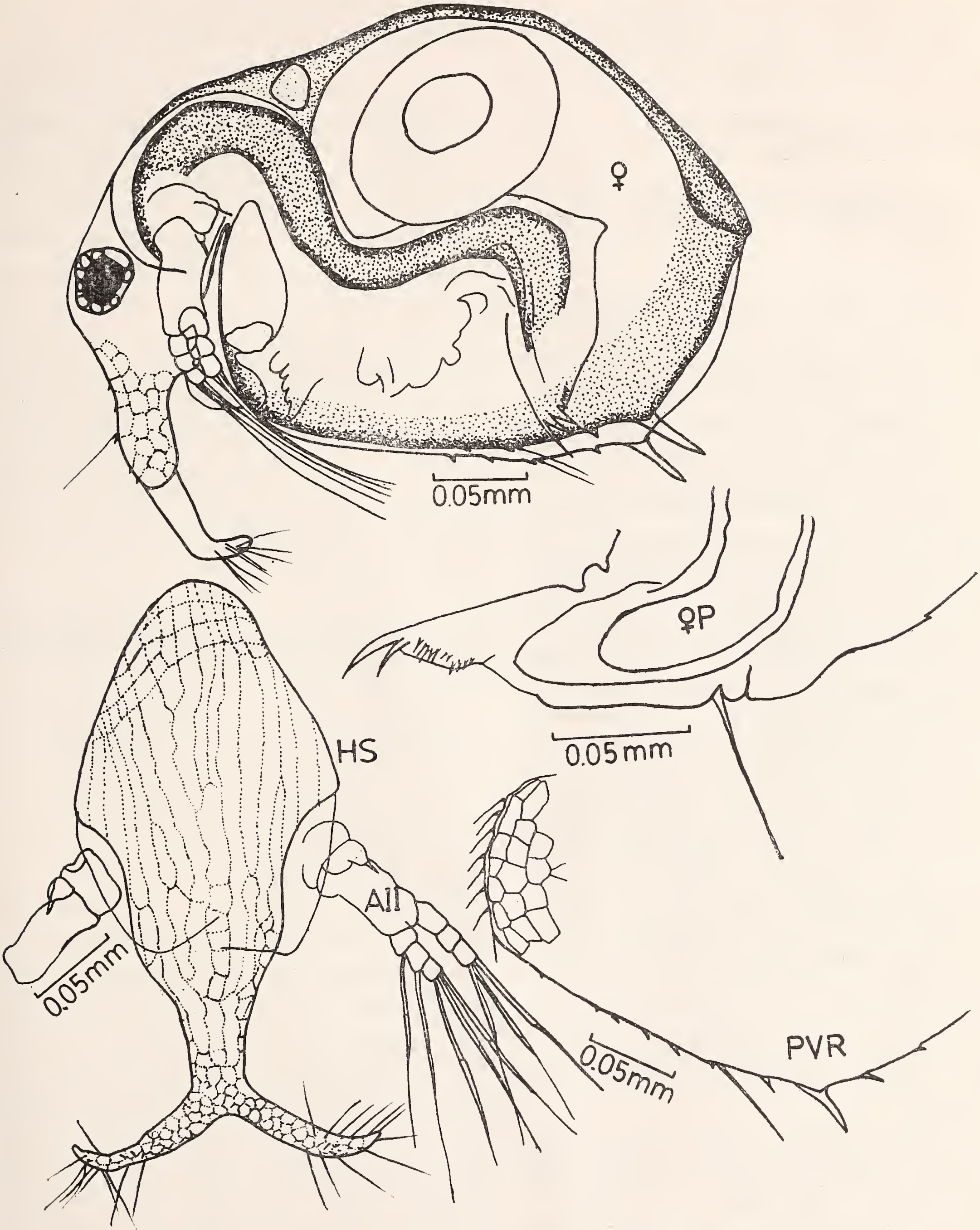
♀
0.05mm
♀P
0.05 mm
HS
AII
0.05mm
0.05mm
PVR

Fig. 2. *Bosminopsis deitersi,* Female: HS — head shield; AII — antenna; PVR — posteroventral corner.

with the occurrence of *Moinodaphnia macleayii* (King, 1853) and *Bosminopsis deitersi* Richard, 1895, new records in Rajasthan.

Family MOINIDAE Goulden, 1967
Genus *Moinodaphnia* Herrick, 1887

1. **Moinodaphnia macleayii** (King, 1853) (fig. 1)

FEMALE: Body length 0.65-0.81 mm (n = 25) mean 0.73 mm. Body compressed and elliptical in shape. Head broad at the base, slightly narrow and rounded anteriorly with a cervical depression separating the head and the posterior part of the body. Eye large, situated near the anterior margin, ocellus small situated closer to antennules than to the eyes. Antennules long and slender, attached to the postero-ventral surface of the head, with a long lateral seta and a group of sensory setae at the apex. Valves broad at the middle (3/4 the size of the length) with faint hexagonal markings. Ventral margin broadly rounded with a series of short marginal spines, posterior corner distinct. Abdomen with two long abdominal processes. Post-abdomen broad on the preanal margin, with a very narrow post-anal projection. Lateral side armed with 11 ciliated spines, the distalmost spine being much larger and bifurcated. Claw rather long with a series of short setules along the concave surface and a small spine at the base of the ventral side.

Distribution: Less common; occurs in weedy habitats, especially in marshes with *Ipomoea* sp.

Remarks: This is the first record of the occurrence of this species in Rajasthan. The present species agrees with the description of Smirnov (1976), Seich-shih and Nan-shan (1979), and Idris (1983).

Family BOSMINOPSIS Sars, 1865
Genus *Bosminopsis* Richard, 1895

2. **Bosminopsis deitersi** Richard, 1895 (fig. 2)

FEMALE: Body length 0.36-0.42 mm, breadth 0.24-0.30 mm (n=25), mean 0.37 mm. Body oval, maximum height near posterior end of the body. Head rounded with a projection just near the eye, rostrum long with two lateral branches near the apex and a long olfactory seta. Eye large, just touching the anterior margin. Valves with faint polygonal reticulation, ventral margin rounded, slightly serrated and with long and pointed marginal spine on the postero-ventral corner. Post-abdomen small and tapering distally, lateral side with two groups of slightly large denticles followed by fine groups of spinules. Claw serrated and concave with a basal spine.

Distribution: Rare, occurring in Ghana canal only during the entry of water from Ajanbund.

Remarks: This is the first record of the occurrence of this species in Rajasthan. Rane (1984) described a new species *B. devendrai*, resembling *B. deitersi*, from a tank near Jabalpur district, Madhya Pradesh. The specimens examined in the present study agree well with Rane's *B. devendrai* except a few characters such as dorsal margin of the carapace without a cervical depression and the absence of a long seta in the postero-ventral corner near the long marginal spine. Idris (1983) described *B. deitersi* from Malaysia, which agrees well with the present specimen in all the characters. However, Seich-chih and Nan-shan (1979) described the same species from China, which differs from the present species in not having a postero-ventral seta and in the number of spines of the post-abdomen. A comparative study on the specimens collected from all these regions may give a clear picture about the taxonomy of this species.

I am grateful for the financial assistance by C.S.I.R., New Delhi and to Prof. T. M. Haridasan for his encouragement.

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37. TWO CORRECTIONS TO THE NOMENCLATURE IN THE REVISION OF *PUERARIA* DC.

Recently, the senior author completed a monographic revision of genus *Pueraria* DC., which contains a couple of oversight errors in the nomenclature of species No. 8 and No. 12.

While working on the monographic revision of genus *Pueraria* DC. the senior author had an opportunity to visit the Blatter Herbarium (BLAT) for examining the materials from Western India. After completing this monographic work a copy of the revision was presented to Blatter Herbarium in appreciation of the help given for examining the materials. In the course of study of this monograph the junior author, who is also interested in the taxonomy and nomenclature of some of the species of this genus in Western Ghats, raised certain queries about the nomenclature of species No. 8 — *Pueraria lobata* (Willd.) Ohwi and two varieties of the taxon. After re-examination of the nomenclature of this taxon we have come to the following conclusions:

1. The earliest name for species no. 8 and its varietal complex is *Dolichos montana*

Loureiro. Merrill (1935) had correctly made the new combination under *Pueraria* DC. According to Article no. 25 of ICBN the correct name for the species should be *Pueraria montana* (Lour.) Merrill. Therefore, the typical variety should be named *Pueraria montana* (Lour.) Merrill var. *montana*.

Type: Loureiro, s.n. — Vietnam, Cochin-China (P.)

Accordingly the other two varieties (*lobata* resp. *thomsoni*) should be named:

2. *Pueraria montana* (Lour.) Merrill var. *lobata* (Ohwi) van der Maesen at Almeida comb. nov.
Basionym: *Pueraria lobata* (Willd.) Ohwi var. *lobata* Ohwi, Bull. Tokyo, Sci. Museum 18: 16, 1947 (see Articles No. 60 & 61 of ICBN).

Type: Illustr. in Houttuyn, nat. Hist. 2, Plate 64, Fig. 1 (1779), p. 153.

3. *Pueraria montana* (Lour.) Merrill var. *chinensis* (Ohwi) van der Maesen et Almeida comb. nov.

Basionym: *Pueraria lobata* (Willd.) Ohwi var. *chinensis* Ohwi, Bull. Tokyo Sci. Museum 18: 16, 1947. (See Articles No. 60 & 61 of ICBN).

Type: S. K. Lau 522 — China (KWA). The remaining synonymy stays correct.

In species No. 12 *Pueraria warburgii* Perkins (1904) has the priority over *Mucuna pulcherrima* Koorders (1908) and should be considered the correct name for the taxon usually listed as *P. pulcherrima* (Kds.) Merr.

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REFERENCE

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38. LICHEN FAMILY COLLEMATACEAE FROM ANDAMAN ISLANDS, INDIA

INTRODUCTION

Nylander (1873) recorded *Leptogium marginellum* (Sw.) S. Gray and *L. tremelloides* (Linn. f.) S. Gray, from Andaman Islands, based on his studies of Kurz's collection. Jatta's investigations (1905) of exotic lichens, collected by E. H. Man, made a reference to

Collema actinoptychum Nyl., *C. pulposum* var. *granulatum* (Sw.) Körb (=*C. granulatum* (Linn. f.), *Leptogium azureum* (Sw.) Mont., *L. pichneum* (Ach.) Malme, *L. puiggarrii* Muell.-Arg., *L. tremelloides* var. *rugulosum* Nyl. (=*L. cimiciodorum* Mass.) and *Collema byrsinum* (Ach.) (=*Physma byrsinum* (Ach.) Muell.-Arg.,) from Andaman Islands. Degelius (1974) in his monographic studies on genus *Collema,* reported the occurrence of *C. coilocarpum* (Muell.-Arg.) Zahlbr., *C. rugosum* Krempelh. and *C. actinoptychum* Nyl., from these islands. This study adds five more taxa of this family from these islands; they are *Physma byrsinum* var. *hypomelaenum* (Nyl.) Hue, *Leptogium austro-americanum* (Malme) Dodge, *L. denticulatum* Nyl., *L. isidiosellum* (Ridd.) Sierk and *L. moluccanum* (Pers.) Vainio.

This paper includes short descriptions of the taxa that have actually been examined by us, numbering nine, while the key includes all the sixteen that have been reported from these islands. The specimens studied are lodged at the herbarium of National Botanical Research Institute, Lucknow (LWG).

KEY TO THE ANDAMAN SPECIES OF COLLEMATACEAE

1. Thallus without a paraplectenchymatous cortex 2
1. Thallus with paraplectenchymatous cortex 5
2. Thallus isidiate .... *Collema rugosum*
2. Thallus without isidia 3
3. Thallus terricolous .... *Collema granulatum*
3. Thallus corticolous 4
4. Thalline exciple scleroplectenchymatous .... *Collema collocarpum*
4. Thalline exciple subparaplectenchymatous .... *Collema actinoptychum*
5. Spores simple 6
5. Spores septate and muriform 7
6. Lower surface of thallus whitish, grey or pale .... *Physma byrsinum*
6. Lower surface of thallus blackish .... *Physma byrsinum* var. *hypomelaenum*
7. Isidia present 8
7. Isidia absent 12
8. Isidia associated only with apothecia .... *Leptogium marginellum*
8. Isidia not associated with apothecia 9
9. Isidia squamuliform ... *Leptogium denticulatum*
9. Isidia not squamuliform 10
10. Thallus surface smooth ... *Leptogium pichneum*
10. Thallus surface wrinkled 11
11. Wrinkles minute, irregular and not raised .... *Leptogium austroamericanum*
11. Wrinkles acute and raised, isidia much branched (rarely squamuliform) .. *Leptogium isidiosellum*
12. Thallus lobes imbricate, margins entire 13
12. Thallus lobes not imbricate, margins entire or lobulate 14
13. Thallus surface rough, margins sinuate and crisp .... *Leptogium moluccanum*
13. Thallus surface rugose-plicate, margins not sinuate and crisp ..... *Leptogium cimiciodorum*
14. Thallus lower surface with impressions of funnel-shaped cavities .... *Leptogium puiggarrii*
14. Thallus without funnel-shaped cavities 15
15. Thallus lead-grey, apothecium with a well developed proper exciple .... *Leptogium tremelloides*
15. Thallus sky-blue, apothecia with a poorly developed proper exciple ... *Leptogium azureum*

1. **Collema actinoptychum** Nyl., Bull. Soc. Linn. Normandie ser. 2.2:43. 1868.

Thallus corticolous, foliose, olivaceous-yellow, olive-green, lobes orbicular, prominently reticulately ridged; isidia absent; apothecia 0.6 mm in diam., slightly constricted at base, epruinose, exciple subparaplectenchymatous; spores fusiform, curved or straight, 5-septate, 36-45 × 3-5 μm.

Specimen examined: Middle Andaman Island, Bajalungta, Singh 52938 (LWG).

2. **C. coilocarpum** (Muell.-Arg.) Zahlbr., Cat. lich. univ., 3: 34, 1925.

— *Synechoblastus coilocarpus* Muell.-Arg., Flora 74: 107. 1891.

Thallus corticolous, foliose, lobes round and discernible, upper surface densely and prominently ridged; isidia absent; apothecia *c.* 2.0

mm in diam., ± constricted at base, epruinose; exciple scleroplectenchymatous; spores fusiform, usually straight; 5-septate, not constricted at septa, 43-64 × 5-7 μm.

Specimens examined: South Andaman Island, Wright Myo, Singh 79702, 79711, 88295 (LWG).

3. **C. rugosum** Kremp., Fenzl., Reise Novara, Bot. 1: 128. 1870.

Thallus corticolous, foliose, greyish green to blackish; lobes rounded, isidiate, isidia globular, branched; apothecia up to 1.25 mm in diam., slightly constricted at base; epruinose exciple scleroplectenchymatous; spores fusiform to bacillar, straight or slightly curved, 5-septate (up to 8-celled, reported by Degelius, 1974), not constricted at septa, 52-65 × 4-6 μm.

Specimen examined: South Andaman Island, Port Blair, Singh 78886, 78887 (LWG), Middle Andaman Island, Bajalungta, Singh 52934, 52938/B (LWG).

4. **Leptogium austroindicum** (Malme) Dodge, Ann. Mo. Bot. Gard. 20: 419. 1933. — *Leptogium cyanescens* var. *austroamericanum* Malme, Ark. Bot. 19(8): 21. 1924.

Thallus corticolous, foliose, loosely to closely attached to substratum, lead grey-brownish, wrinkled, wrinkles minute, irregular and not raised, lobate, lobes discrete, margin isidiate, isidia simple, globular or rarely branched and squamuliform; apothecia absent in the specimen examined.

Specimen examined: South Andaman Group, Baratang Island, Nilambur (Oral Kacha), Singh 79720 (LWG).

5. **L. denticulatum** Nyl., Ann. Soc. Nat. Bot. ser. 7: 302. 1867.

Thallus corticolous or saxicolous, foliose, loosely to closely attached to substratum, lead grey, lobate; lobes discrete, adnate, imbricate, margin entire or isidiate lobulate; upper surface smooth, isidiate, isidia squamuliform; apothecia not seen in the specimens examined.

Specimens examined: South Andaman Island: Mount Harriat, Singh 67634 (LWG); T.L.D. range, Singh 88232 (LWG); Middle Andaman Island; Parlobjig, Singh 79807, 79813, 79836, 79839, 79884, 79898 (LWG).

6. **L. isidiosellum** (Ridd.) Sierk, Bryologist, 76: 282. 1964. — *Leptogium marginellum* var. *isidiosellum* Ridd; Brooklyn Bot. Gard. Mem. 1: 115. 1918.

Thallus corticolous, foliose, lead-grey to brownish-black, lobate, lobes discrete, orbicular, margin imbricate, entire or isidiate; upper surface reticulately wrinkled, isidia laminal to marginal, simple to coralloid branched; lower surface reticulately wrinkled. Apothecia absent in the specimens examined.

Specimens examined: South Andaman Island, Mount Harriat, Singh 67623; Middle Andaman Island, Bajalungta, Singh 52948 (LWG).

7. **L. moluccanum** (Pers.) Vainio, Etud. Lich. Bresil. 1: 223. 1890. — *Collema moluccanum* Pers., Gaud. Voy. Uran. Bot., 203: 1826.

Thallus corticolous, foliose, yellowish-grey to greenish-grey or dark lead-grey, lobate, lobes discrete, margin entire, isidia absent; upper surface rough; lower surface concolorous with the upper surface, rough; apothecia 2.0 mm in diam., constricted at base, shortly stalked, epruinose; spores muriform, transversely 4-septate, longitudinally 1-3-septate, fusiform, 28-31 × 11-14 μm.

Specimen examined: Middle Andaman Island, Parlobjig, Singh 79819 (LWG).

8. **Physma byrsinum** (Ach.) Muell.-Arg., Flora 58: 531. 1885. — *Parmelia byrsea* Ach., Method. Lich., 222. 1803.

Thallus corticolous, foliose, brownish-grey, lobate, lobes irregular, upper surface rough, finely reticulately rugose, lower surface grey; asci 8-spored; spores simple, hyaline, spindle shaped to globose, 15-25 × 8-12 μm.

Specimen examined: South Andaman Island, Wright Myo, Singh 7905 (LWG).

9. **Physma byrsinum** var. **hypomelaenum** (Nyl.) Hue, Bull. Soc. Linn. Normandie 5 ser. 9: 130. 1906. — *Collema byrsinum* f. *hypomelaenum* Nyl., Ann. Sci. Nat. Bot. 4 ser. 12: 281. 1859.

Similar to *P. byrsinum* var. *byrsinum* except the blackish colour of lower surface.

Specimen examined: South Andaman Island, Wimberly Gunj, Singh 88271 (LWG).

ACKNOWLEDGEMENTS

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39. *ASPLENIUM BULLATUM* WALL. EX METT. (ASPLENIACEAE) — A NEW RECORD FOR NORTH-WESTERN HIMALAYA FROM KUMAUN HILLS

During the course of explorations of the fern flora of Kumaun Himalaya, some specimens of a very interesting fern were collected. It was later identified as *Asplenium bullatum* Wall. ex Mett., an identification confirmed by Dr. S. P. Khullar, Botany Department, Panjab University, Chandigarh. A critical scrutiny of herbaria and literature dealing with the ferns of North-Western Himalaya indicates that this species has not yet been reported from North-Western Himalaya and is so far known only from Nepal, Sikkim, Bhutan, Khasia, Penang, Malay Peninsula, Australia, New Zealand, Mexico, New Caledonia, Natal and the east African Islands. The collection of this species from Kumaun Himalaya extends its distributional range further west to North-Western Himalaya, and it is an important addition to the fern flora of North-Western Himalaya in general and Kumaun Himalaya in particular.

This paper provides a brief description of *Asplenium bullatum* Wall. ex Mett. along with other relevant information. The field number along with collector's name is given in brackets and the voucher specimens are deposited in the Herbarium, Botany Department, D. S. B. College, Kumaun University, Naini Tal.

Asplenium bullatum Wall. ex Mett., Aspl. 51. 1859; Dixit, Census Indian Pterid. 116. 1984. *A. bulbiferum auct.* Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1: 485. 1880; Bedd., Handb. Ferns Brit. India 159. 1883.

Rhizome stout, thick. Stipe 15-35 cm long, stout, erect, slender, scaly near the base. Fronds 30-120 cm long, oblong-lanceolate or ovate-lanceolate, 2-3 pinnate. Pinnae in many pairs, horizontal, cut down to the compressed winged rachis, into many lanceolate-deltoid pinnules which are cut down into slightly toothed linear, oblong, flaccid segments, texture herbaceous. Veins pinnate, firm. Sori oblong, large, often filling the whole segment and visible from the upper surface. Spores light reddish-brown, densely granulose.

Habitat: Rare fern which grows in dark shaded, humus rich forest floors in ravines around 1300 m.

Specimens examined: Kumaun Himalaya: Pithoragarh district, Banlekh around 1300 m (YPSP 900).

ACKNOWLEDGEMENTS

We are thankful to Dr. S. P. Khullar, Botany Department, Panjab University, Chandigarh for confirming the identity of the species. Thanks are due to Head, Botany Department, D. S. B. College, Kumaun University, Naini Tal for providing necessary facilities.

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40. POLLEN MORPHOLOGICAL VARIATIONS AMONG THREE TAXA OF RUTACEAE

INTRODUCTION

The pollen morphology of three taxa of Rutaceae has been studied. In Rutaceae, the sporomorphs are colporate, but the apertures range from 3-8 and hence it is a less multipalynous family (Nair 1970). The pollen grains are isopolar, radiosymmetric, diaperturate to polyaperturate and suboblate to perprolate (cf. Erdtman 1952).

MATERIAL AND METHODS

The material for the present investigation was collected from Narthamalai, Tambaram, and Chidambaram (Table 1).

TABLE 1

Sl. No.	Taxa	Location	Voucher No.
1.	*Clausena willdenovi* W. & A.	Narthamalai	28
2.	*Glycosmis cochinchinensis* Pierre	Tambaram	20
3.	*Limonia acidissima* Linn.	Chidambaram	19

The grain characteristics were worked out from mature pollen grains tapped from open flowers. The pollen grains were dusted on a clean slide and stained with a drop of 1% acetocarmine. The size, shape, type and the wall-thickness were measured. The percentage of pollen fertility was also calculated.

OBSERVATIONS

The descriptions of pollen grains of the three taxa are as given below:

Clausena willdenovii W. & A. 3-zonocolporate, sub-prolate (23.24 × 18.42 μm). Sexine thinner than the nexine, psilate. Germpore lalongate.

Glycosmis cochinchinensis Pierre 3-zonocolporate, sub-prolate (22.0 × 18.0 μm). Sexine as thick as nexine, faintly reticulate, germpore lalongate.

Limonia acidissima Linn. 4-zonocolporate, prolate spheroidal (22.80 × 20.96 μm). Sexine as thick as the nexine, coarsely reticulate with large brochi. Germpore lalongate.

The details regarding the size, shape, type, L/S ratio and wall thickness are given in Table 2.

On the basis of Erdtman's (1945) system, based on size, the pollen grains of the three taxa have been grouped under small sized spores (10-25 μm).

TABLE 2

POLLEN MORPHOLOGICAL FEATURES OF THE TAXA INVESTIGATED

Sl. No.	Taxa	Type	Shape	Length in μm	Breadth in μm	L/B ratio	Wall thickness	Fertility %
1.	*Clausena willdenovii*	Psilate	Sub-prolate	23.24 (0.544)	18.42 (0.203)	1.26	3.94 (0.320)	86
2.	*Glycosmis cochinchinensis*	Reticulate	Sub-prolate	22.00 (0.501)	18.06 (0.492)	1.22	3.43 (0.289)	78
3.	*Limonia acidissima*	Reticulate	Prolate spheroidal	22.80 (0.639)	20.96 (0.535)	1.09	3.68 (0.344)	82

Standard errors of mean values are furnished within brackets.

DISCUSSION

The Palynological study of the three taxa reveals only colporate type of pollen grains. Reticulation with large brochi has been noted in *Limonia acidissima.* Faintly reticulate grains occur in *Glycosmis cochinchinensis* and those of *Clausena willdenovii* happen to be psillate. Sub-prolate type has been observed in *G. cochinchinensis* and *C. willdenovii,* whereas the prolate spheroidal type was found in *L. acidissima.* The maximum pollen fertility (86%) was observed in *C. willdenovii.*

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41. *MERREMIA QUINQUEFOLIA* (LINN.) HALL. F.: A NEW RECORD FOR EASTERN INDIA

While exploring the flora of Dhenkanal district during the last three years, several interesting plants could be collected among which *Merremia quinquefolia* (Linn.) Hall. f. proves to be a new record for the state of Orissa. After perusal of available literature and survey of authentic specimens extant at different herbaria of India it has been concluded that this taxon is also a new record for Eastern India. It has restricted distribution and has so far been reported from Maharashtra (Naik 1979), Gujarat (Raghavan *et al.* 1981) and Rajasthan (Bhandari 1978). The specimen has been housed in the herbarium of P.G. Dept. of Botany, Utkal University, Bhubaneswar.

Merremia quinquefolia (Linn.) Hall. f. in Engler Bot. Jahrb. 16: 552. 1893; Ooststr. in Blumea 3: 324. 1939 *et* in Fl. Malesiana (ser. 1) 4: 446. 1953; Bhandari in Fl. Ind. Desert 263. 1978. *Ipomoea quinquefolia* Linn. Sp. Pl. 162. 1753. (CONVOLVULACEAE).

A twining herb. Stem glabrous to sparsely pubescent upwards. Leaves palmately compound; petiole upto 4 cm. long; leaflets 5, sessile or shortly petioluled, narrowly oblong or lanceolate, distantly shallowly serrate; central leaflet larger, 6.5 × 2 cm; laterals smaller, 2-4 × 1-2 cm, attenuated at both ends. Inflorescence axillary, leaf-opposed, 3-5 flowered cyme. Peduncle upto 10 cm. long. Flowers pedicelled. Bracts narrow-triangular, acute. Calyx oblong, obtuse at apex, subequal. Corolla funnel-shaped, creamish-yellow, glabrous. Stamens 5, subequal, inserted above the base of corolla; filaments thinly pubescent at their dilated base. Ovary glabrous. Capsule globose, 4-celled. Seeds 4, greyish-black, with appressed curled hairs.

Fls. & Fr.: April-Sept.

Illus.: Bhandari, Fl. Ind. Desert 263. f. 97. 1978.

Specimen examined: FCI (Talcher), B.C. Patra, 11475. Not common.

Herbarium specimens examined: Nagpur, M. Phirashi 336/6.1 1960; 312868 (CNH).

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42. RELATIONSHIP BETWEEN PYRROLIZIDINE ALKALOIDS, DANAINE BUTTERFLIES AND *AGERATUM CONYZOIDES*

Ackery & Vanewright (1984) claimed that male butterflies need pyrrolizidine alkaloids in order to activate them sexually before a successful courtship. They further claimed that these males are attracted towards plants which contain these alkaloids in order to fulfil their demand. *Ageratum conyzoides* was claimed to be one such plant.

In a recent communication Larsen (1986) has further supported this view when he observed clusters of males on *Ageratum conyzoides* from various locations from Delhi. Larsen too concluded that this particular plant acts as a source of these alkaloids.

For a number of years we have been engaged in screening Indian Botanicals in search of new crop protection chemicals. Having acquired considerably literature on plants known for this activity we compiled the data on *Ageratum conyzoides* as this is well known to produce anti-juvenile hormones, i.e. precocenes I & II (Fagoonee *et al.* 1981). As reported by Darvas *et al.* (1986), precocenes induce reversible precocious metamorphism and sterilization of insects by suppressing the function of the corpora allata glands. This data clearly showed that no alkaloid has either been isolated or otherwise claimed to be present in this species. On the other hand a number of oxygen heterocycles have been reported from this plant.

In order to further confirm the presence or absence of alkaloids in *Ageratum conyzoides*, we separately extracted the flowers and remaining plant with cold petroleum ether followed by cold methanol (Room temperature, 24 hours). After removal of solvents when these extracts were treated with Mayer's or Dragendorf's reagents as these are well known to show diagnostic colour reactions with alkaloids, no such coloration was observed thereby indicating absence of alkaloids.

Keeping this observation in view, it appears that the reasons of attraction of male Danaines towards *Ageratum conyzoides* is not the presence of alkaloids but some other unknown factors.

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43. NOTES ON THE DISTRIBUTION OF RARE AND LITTLE KNOWN *TANACETUM NUBIGENUM* WALL. EX DC. (ASTERACEAE) FROM NORTHWEST HIMALAYA

(*With a text-figure*)

During germplasm exploration and collection trip to Garbyang (*en route* Mansarovar Kailash), district Pithoragarh, in October, 1986 we collected a rare and interesting medicinal and aromatic plant from the interior grassy localities, stone slopes, and sandy soils in the rather arid areas of Garbyang, predominantly a tribal area (63 km away from Tawaghat, last bus terminus), surrounded by mountains, gorges, and valleys with alpine vegetation. The species was identified as *Tanacetum nubigenum* Wall. ex DC. (Asteraceae).

This plant has been reported from Pindari Glacier, Kuti Valley, Byans valley (Almora and Pithoragarh districts); Tungnath, Vashudhara, Tapovan, Chamba, Gangotri (Chamoli, Uttarkashi and Tehri districts); Shetiker-Spiti, Thali Bazar (Himachal Pradesh) areas. The presence of this species in Garbyang area hence forms a new distributional record for North-West Himalaya. Seeds have been collected and the plant specimen has been preserved by the authors at N.B.P.G.R., Regional Station-Bhowali Herbarium (N.B.P.G.R.H. - 130).

Tanacetum nubigenum Wall. ex DC. Prodr. 4: 130, 1836; Hook. f. FBI 3: 378-379, 1881; Atkinson, 508-509, 1882; Collett, 265, 1902; Duthie, 92, 1906. (Fig. 1).

Erect, woolly, aromatic, 30-45 cm tall, perennial herb. Stems many, arising from a woody base, often branched and rooting at the base. Leaves sessile, alternate, 3-pinnatisect, 1.2-4.0 × 0.1-0.3 cm; segments linear-lanceolate, subacute, entire, glabrous or appressed, hairy on both surfaces. Heads discoid, many-peduncled or sessile, 3-5 mm in diameter, in terminal corymbs. Involucral bracts broadly oblong, many erect, woolly haired, margins scarious, purple-brown, outermost linear. Corolla or disk-florets 2-5 mm long, 5-ribbed, bright yellow. Achenes smooth, ovoid-oblong. Receptacle slightly convex; pappus none.

Flowering and Fruiting: July-October.

Reference No.: National Bureau of Plant Genetic Resources, Bhowali Herbarium (N.B.P.G.R.H. - 130 — K.S.N. & K.C.P.).

Note: Easily distinguishable from other species of *Tanacetum*, having taller stems 30-45 cm, smaller flower heads, 3-5 mm in diameter, and leaves tripinnatisect, linear,

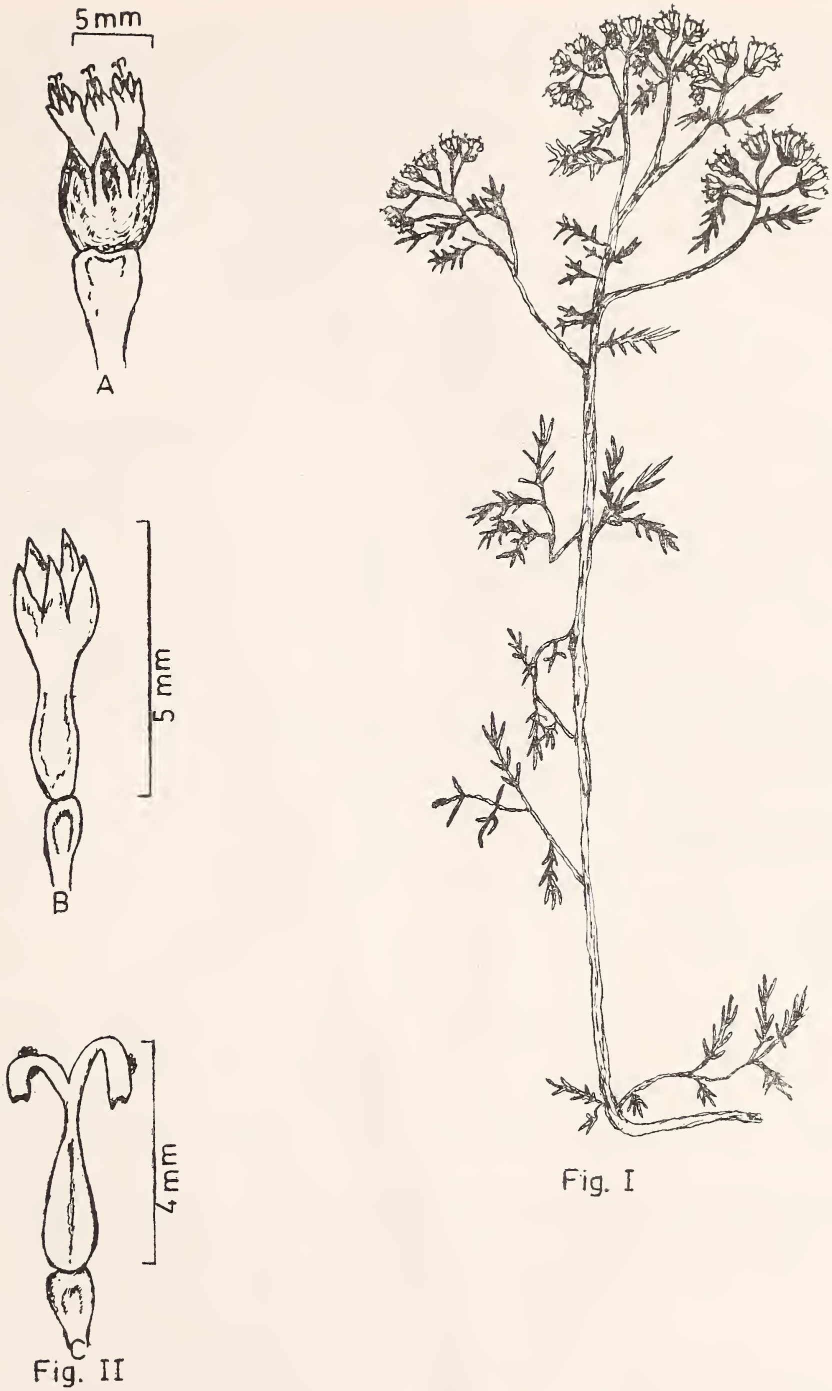
5mm
A
5 mm
B
4mm
C
Fig. II
Fig. I

Fig. 1. *Tanacetum nubigenum* Wall. ex DC.
I: Flowering spikes with leaves.
II: A. Floral Heads (Involucral bracts, Disk florets and reproductive organs).
B. Disk-florets. C. Reproductive (Ovary, Stigma and Style).

acute lobes. A silvery-grey tufted plant with usually many stems arising from the rootstocks.

Earlier records: This species was first reported in 1883 and sporadic reports of its occurrence were available since then. It is being reported from the Garbyang region for the first time.

Distribution: Kuti Valley-Kumaon, 11200′ 11.9.1884-J. F. Duthie, DD-3057; Phula Valley, Nila Valley-Tehri Garhwal, 15.8.1883-J. F. Duthie, DD-840; Byans Valley-Kumaon, 11200′, 17.7.1886-J. F. Duthie, DD-6593; Thali Bazar-Himachal Pradesh, 9000′, 8.10.1877-DD-566213; Pindari Glacier-Kumaon, 11200′, 17.7.1885-C. E. Paskiem, DD-5980; Chamba-Ilas-Tehri Garhwal, 11000′, 17.9.1896-G. A. Gamble, DD-18629; Vashudhara-Chamoli Garhwal, 3500 m, 10.10, 1959-M. A. Rao, BSD-10546; Pindari-Moraine-Kumaon, 20.9.1957-T. A. Rao, BSD-4432; Tapovan-Uttarkashi, 23.8.1967-B. D. Naithani, BSD-37419; Chamoli Garhwal, 1.9.1975-B. D. Naithani, BSD-37370; Shetiker-Spiti-Himachal Pradesh, 10.9.1961-N. C. Nair, BSD-16831.

Habitat: Rare, in alpine meadows on stony slopes, sandy soil and arid areas, associated with *Allium stracheyi, Arnebia benthamii, Calamagrostis emodensis, Deyeuxia pulchella,* 3800 m altitude.

Uses: This species and its allied species are used as an incense under the name 'Guggul' or 'Dhoop'.

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44. ON THE OCCURRENCE OF *HOLCOLEMMA CANALICULATUM* (NEES EX STEUD.) STAPF ET HUBBARD, A RARE GRASS TO SOUTH INDIA, AT POINT CALIMERE WILDLIFE SANCTUARY, TAMIL NADU

A study on the flora of Point Calimere Wildlife Sanctuary during 1982 resulted in the finding of a rare and interesting grass *Holcolemma canaliculatum* Stapf et Hubbard. The same grass had been rediscovered after a lapse of several decades from Ramanathapuram

District of Tamil Nadu by N. C. Nair, and S. R. Srinivasan, during 1980 at an altitude of 210 feet MSL.

Holcolemma canaliculatum (Nees ex Steud.) Stapf et Hubbard in Kew Bull. 1929: 246. 1929; Fischer in Gamble, Fl. Pres. Madras 10: 1779. 1934 and 3: 1232. 1957 (repr. ed.); Bor grass. Burma, Cey., India, Pakist. 313. 1973 (repr. ed.). *Panicum canaliculatum* Nees ex Steud. — Syn, pl. Glum. I: 55. 1854, Hook, f. Fl, Brit. India 7; 43. 1896.

In 1854, Steudel validly described this species under the genus *Panicum* L. Hooker (l.c.) while treating this species however, remarked; "It is a very peculiar species". Stapf and Hubbard (l.c.) accommodated this species in the newly erected genus *Holcolemma* Stapf et Hubbard. Hooker (l.c.) indicated its distribution truly as a Southern Deccan peninsula, without any precise locality. Fischer (l.c.) who also stated: "Precise locality unknown". Bor (l.c.) remarked that "this species has only been collected on very few occasions. ...." (Nair & Srinivasan 1982). It is interesting to note that this rare grass could be located from Point Calimere Wildlife Sanctuary, Thanjavur District of Tamil Nadu. It is noteworthy to mention here that Point Calimere lies in the coastal belt (sea level) whereas the locality reported by Nair and Srinivasan lies at 210 feet MSL.

Perennial herbs: culms 4.75 feet high, very slender; weak; nodes glabrous. Leaves 9.5-21 × 0.35-0.65 cm, linear flat; sheaths up to 6.5 cm long, glabrous. Panicles narrow, spiciform; spikelets solitary or fascicled on a slender rachis. Glumes unequal, florets 2, the lower male, the upper hermaphrodite; lower lemma saccate below, membranous with a median furrow, paleate; upper lemma crustaceous, transversely rugose, paleate.

The specimen is deposited in the A.V.C. College herbarium, Mayiladuthurai and Avifauna Project herbarium, Point Calimere.

Distribution: South India, Sri Lanka and Kenya.

ACKNOWLEDGEMENTS

We express our sincere thanks to Dr. N. C. Nair, Director, Botanical Survey of India, Southern Circle, Coimbatore and Mr. Srikumar Nair, Research Fellow of the same Institute for identifying the specimen.

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45. *TRICHOLOMA PRATENSE* (AGARICALES): A NEW INDIAN RECORD

(*With a text-figure*)

Tricholoma pratense Pegler & Rayner was collected during a taxonomic study of the mushroom flora of Orissa from 1980-1983. For the taxonomic details and matching of the fungus, Pegler and Rayner (1969) was followed and for colour terminology, Ridgway (1912). The new record from India was ascertained by Manjula (1983). The specimen has been deposited at the Herbarium Cryptogamae Indiae Orientalis, Division of Mycology and Plant Pathology, IARI, New Delhi. The fungus has been reported earlier only from Kenya (East Africa) by Pegler and Rayner (1969), and is being reported for the first time from India.

Tricholoma pratense Pegler and Rayner in Kew Bull. 23: 404 (1969). (Fig. 1).

Pileus 30-50 mm diameter, globose at first, then convex to planoconvex; cuticle brownish-buff near disc, slightly faded towards margin, glabrous, thick, leathery, not easily separable, dry, not viscid; margin non-striate, incurved at first, later cernuous; context fleshy, up to 5 mm broad near disc, white, unchanging when brushed. Lamellae uncinate to adnate, ivory colour moderately distant, ensate, attenuate, thick, 1.5 to 3.5 mm broad near centre; lamellulae of 4-6 lengths; edge entire. Stipe 55-85 × 8-13 mm, erect, cylindrical, equal, occasionally narrow towards base, sometimes compressed, blunt base; surface white, dirty white with age, fibrillose; context solid, soft, fibrous, white. Annulus and volva absent. Taste and odour indistinctive. Spore print pure

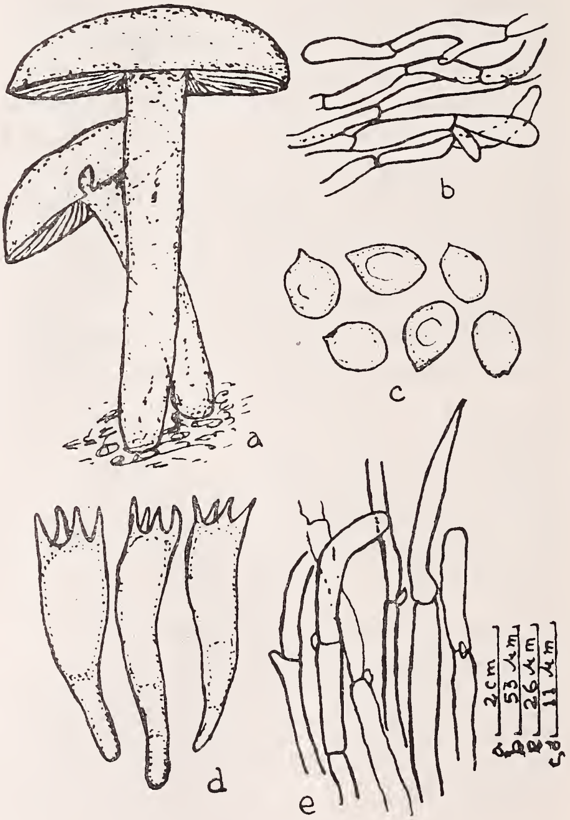

Fig. 1. *Tricholoma pratense* Pegler & Rayner
a. Habit; b. Pileal epicutis; c. Spore; d. Basidia; e. Stipe tissue.

white. Spores 5.5-7.7 × 4.4-5.0 μm, subglobose to obovate, hyaline, smooth, thin walled, inamyloid; with one or two refractive oil guttules; apiculus often prominent. Basidia 22.0-30.8 × 4.4-6.6 μm, cylindrical to subclavate, thin walled, hyaline; sterigmata four, 1.7-4.0 μm long. Lamella-edge fertile. Cystidia absent. Pileal epicutis interwoven, thin walled, hyaline, branched, repent hyphae, 4.0-8.6 μm diameter with apical cells of 5.0-11.5 μm broad. Pileal context interwoven, thin walled hyaline, branched hyphae of 5.0-8.8 μm diameter. Stipe tissue thin walled, elongated, hyaline hyphae, 4.0-7.6 μm broad. Clamp connections abundantly present.

Habitat: Solitary and gregarious, among leaf litter of Moon flower (*Ipomoea bonanox* L.); at Ajodhya, district Balasore; alt. 555 m; 16th August, 1981; H.C.I.O. No. 36840.

We are thankful to Dr. J. N. Kapoor, Senior Mycologist, Division of Mycology and Plant Pathology, IARI, New Delhi for his kind help in confirming the identity of the fungus.

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46. *GERANIUM CAROLINIANUM* LINN. — AN ADDITION TO THE INDIAN FLORA FROM PATIALA DISTRICT, PUNJAB

(*With a text-figure*)

During our plant collection trips in Patiala and its neighbourhood in the spring seasons of 1985-1987, some specimens belonging to the genus *Geranium* Linn. (Family Geraniaceae) were collected. After investigation and subsequent confirmation at Kew Herbarium, these were identified as *G. carolinianum* Linn. — a North American taxon. The species has not been reported earlier from India by Edgeworth & Hooker (1874) or in the subsequent compilatory lists of new records to Indian flora (Calder *et al.* 1926, Razi 1959, Nayar & Ramamurthy 1973, Ghosh & Dutta 1976, Ghosh 1977, 1979 and Nayar & Karthikeyan 1981). Apparently *G. carolinianum* Linn. is a new addition to the Indian flora and appears to be an accidental introduction. Some relevant taxonomic information regarding the species is furnished below:

Geranium carolinianum Linn. Sp. Pl. 682. 1753; Deam, Fl. Indiana 625. 1910 (repr.

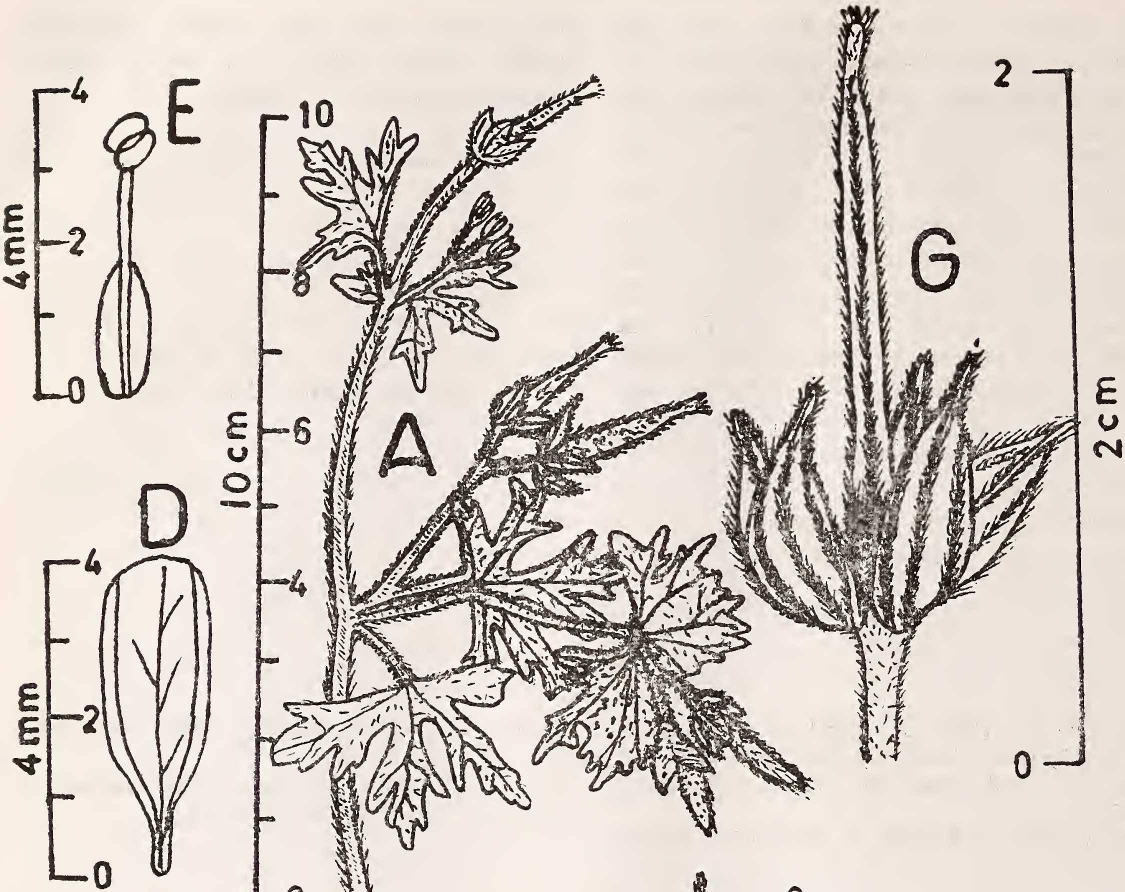
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Fig. 1. *Geranium carolinianum* Linn.
A. Flowering and fruiting branch; B. Flower; C. Sepal; D. Petal; E. Stamen; F. Gynoecium; G. Fruit; H. Mature carpel body; I. Seed.

ed. 1970); Gleason, New Britton and Brown, Ill. Fl. Northeast United States 2: 458. 1968; Wiggins, Fl. Baja California 639. 1980; Martin & Hutchins, Fl. New Mexico 1: 1119. 1980. (Fig. 1).

An annual herb with a slender tap root. Stems several from the base, 15-45 cm long, suberect at the base with spreading or ascending branches, densely patent- or retrose-hispid or hirsute as are also the petioles, peduncles and pedicels, glandular on the upper parts especially in the inflorescence region. Radical leaves short-lived; cauline leaves numerous, petioles 1.2-10 cm long; blades 2-6 cm wide, reniform or orbicular- reniform in outline, thin, appressed hispid-hairy on both sides, divided three fourths to almost to the base into usually 5 (rarely 3 or 7), nearly equal cuneate lobes, lobes deeply divided and toothed at the apex with linear-oblong, subobtuse or obtuse segments; stipules 4-7 mm long, lanceolate, acuminate, thinly pubescent with ciliate margins. Peduncles 1-3 cm long, slender, 2-flowered, solitary axillary or loosely aggregated in terminal, 4-12-flowered, umbel-like clusters. Pedicels 0.5-1 cm long. Sepals 4-5 × 3-4.5 mm (excluding ± 1 mm long awn), enlarged and reddish-tipped in fruit, ovate or elliptic-ovate, 3-nerved, hirsute on the veins and margins without, glabrous within, Petals ± 4.5 × 2 mm, cuneate with a small claw and three prominent veins, light pink to whitish. Filaments ± 3.5 mm long, broadened in the lower half. Fruits 1.3-1.7 cm long (including 1-2 mm long stylar beak), densely gland-hispid. Mature carpel body 3-3.5 × ±2 mm, ovoid, black, villous with ascending hairs. Seeds ± 1.5 long, ellipsoid, dark brown, shallowly reticulate with elongate and irregular areoles.

Specimens described: Modi Mandir, Patiala, Baradari Gardens, Patiala; *M. Sharma* 9689 & 14309, 12497 (PUN). Ranjit Bagh, Patiala, V. K. Singhal 12951 (PUN).

Fls. & Frts.: February-April.

Distribution: Native of North America.

Ecology: The plants seem to have a preference for shade and grow in garden beds or along irrigation channels in the gardens.

Illustration: See Fig. 1.

In general characteristics this species is close to another annual of the genus *Geranium* found in Punjab, namely *G. rotundifolium* Linn. However, in the latter taxon the fruiting pedicels are deflexed and petals distinctly exceed the sepals. On the other hand, in the present species fruiting pedicels are erect and petals are smaller than or hardly as long as sepals. In general appearance *C. carolinianum* is relatively more robust and has larger leaves in comparison to *G. rotundifolium.*

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BREEDING BIOLOGY OF THE INDIAN REEF HERON[1]

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(*With five plates and a text-figure*)

The breeding biology and nesting requirements of many heron species have been studied in several countries. The breeding biology of the Grey Heron, *Ardea cinerea,* has been studied by Verwey (1930), Lowe (1954), Owen (1960), Milstein *et al.* (1970); of the Purple Heron, *Ardea purpurea,* by Steinfatt (1939), Owen and Phillips (1956) and Tomlinson (1974a, 1974b, 1975); of the Great Blue Heron, *Ardea herodias,* by Vermeer (1969), Pratt (1970, 1972), Werschkul *et al.* (1977), and of the Great, White or Large Egret, *Ardea alba,* by Teal (1965), Pratt (1970, 1972), Maxwell & Kale (1977). The Green Heron, *Butorides virescens* has been studied by Dickerman & Gavino (1969) and Boat-billed Heron, *Cochlearius cochlearius* by Dickerman and Juarez (1971). The breeding biology of Cattle Egret, *Bubulcus ibis,* has been studied by several investigators (Skead 1966, Lowe-McConnell 1967, Blaker 1969, Jenni 1969, Dusi and Dusi 1970, Lancaster 1970, Siegfried 1972, Weber 1975, Maxwell and Kale 1977). The other herons that have been studied are the Little Egret, *Egretta garzetta* by Voisin (1976, 1977, 1979), and Night Heron *Nycticorax nycticorax* by Nickel (1966) and Voisin (1970). However, there is very little information available about breeding biology of the reef herons. A brief account of the interbreeding between colour phases and the timing of breeding season of the Indian Reef Heron, *Egretta gularis* (Bosc), now considered by Hancock and Kushlan (1984) as *E. garzetta schistacea* is given by Naik *et al.* (1981). The breeding biology of the Indian Reef Heron described in this paper forms a part of our detailed studies on the biology of the bird.

Material and Methods

The study was made mainly at the Gogha and New Port heronries, described earlier by Naik and Parasharya (1987), from February to

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June, 1980. The nesting trees were numbered and a large number of nests were individually marked by numbered plates during the nest-building stage. The nests were checked by climbing the tree. The freshly laid eggs were numbered with a felt-tipped pen, measured with Vernier calipers and weighed to the nearest 0.5 g with a Pesola spring-balance.

The nests were checked every day during the laying period, at four or five-day intervals during the incubation and hatching periods and at weekly intervals from the time chicks hatched, till they reached the age of 24 days. At other times, the observations were made from the ground, using 10× binoculars.

RESULTS AND DISCUSSION

Nesting season:

The nesting season of 1980 started in early February—the earliest nests were started on 10th in New Port and on the 5th in Gogha. The season terminated in September, the last chicks having left their nests on the 10th at New Port and on the 13th at Gogha. The nesting was at its peak in April.

Colony Development:

The herons were thinly distributed along the coast during non-breeding season; they even wandered inland so that one or two reef herons were seen at almost every inland reservoir. They, however, converged towards their traditional nesting sites closer to the coast during the breeding season.

During the non-breeding season, the reef herons of New Port left the roost in the morning around sunrise, and returned to the roost only around sunset; between sunrise and sunset, they did not visit the roosting trees even during high tide. With the approach of the nesting season, an increasing number (Fig. 1) of reef herons started roosting on the same trees on which they eventually nested. Our observations on the heronries elsewhere in Gujarat indicate that the herons did not always use the roosting trees for nesting. Apparently, the roosting trees were also used for nesting wherever the trees provided safety and the nearby feeding grounds assured ample food supply throughout the nesting season.

As the nesting season approached closer, a few birds delayed their departure from roosting trees in the morning, if it was around high tide time. Similarly, they started arriving at roost earlier than their normal time, if the high tide occurred in the evening. The birds did not remain in their colony during the low tide hours. In an initial stage, there were only a few such birds and they were not very noisy. After a few days, more and more of them remained on the colony during daylight hours, and their vocalization during territorial and courtship displays made the colony noisy. Though almost all the birds had fully developed plumes, colour of the soft parts did not change in all of them. The number of birds with nuptial colour on their soft parts increased as the colony developed. A detailed account on the soft part colour changes associated with nesting is given by Parasharya and Naik (1987).

The first nest at Gogha in 1980 was built on a tamarind tree on which the Painted Stork (*Mycteria leucocephala*) still had grown chicks. There were two nests of the herons in an initial stage of nest-construction on 6 February, 1980. At this time, the birds left the nest sites unguarded when they foraged during low tide. But when intensive nest-building started a few days later, at least one bird per nest always remained at the site. The first eggs appeared in nests on 17 February. Timings of main nesting events at the Gogha colony during 1980 were as follows:

3 February: first reef heron observed at a nesting site
5 February: first copulation observed

17 February: first egg laid
Between 13 and 15 March: first chick hatched
Between 15 and 23 August: last egg laid

NEST AND NEST-BUILDING

At the Gogha colony, only a few old nests of the herons had remained on the trees at the approach of nesting season in February, but at the New Port colony there were many old nests available at the start of nesting season. The herons readily occupied the old nests, repaired them and laid eggs, though in several cases the old nests were dismantled and transported piece by piece to make new nests elsewhere. There were 16 old nests of the Painted Stork at Gogha when the herons started nesting and the herons dismantled them within a month and a half to re-use the material for their nesting. Similarly, material from an old nest of the House Crow (*Corvus splendens*) was also re-used. During the second nesting peak in July, old nests of the heron

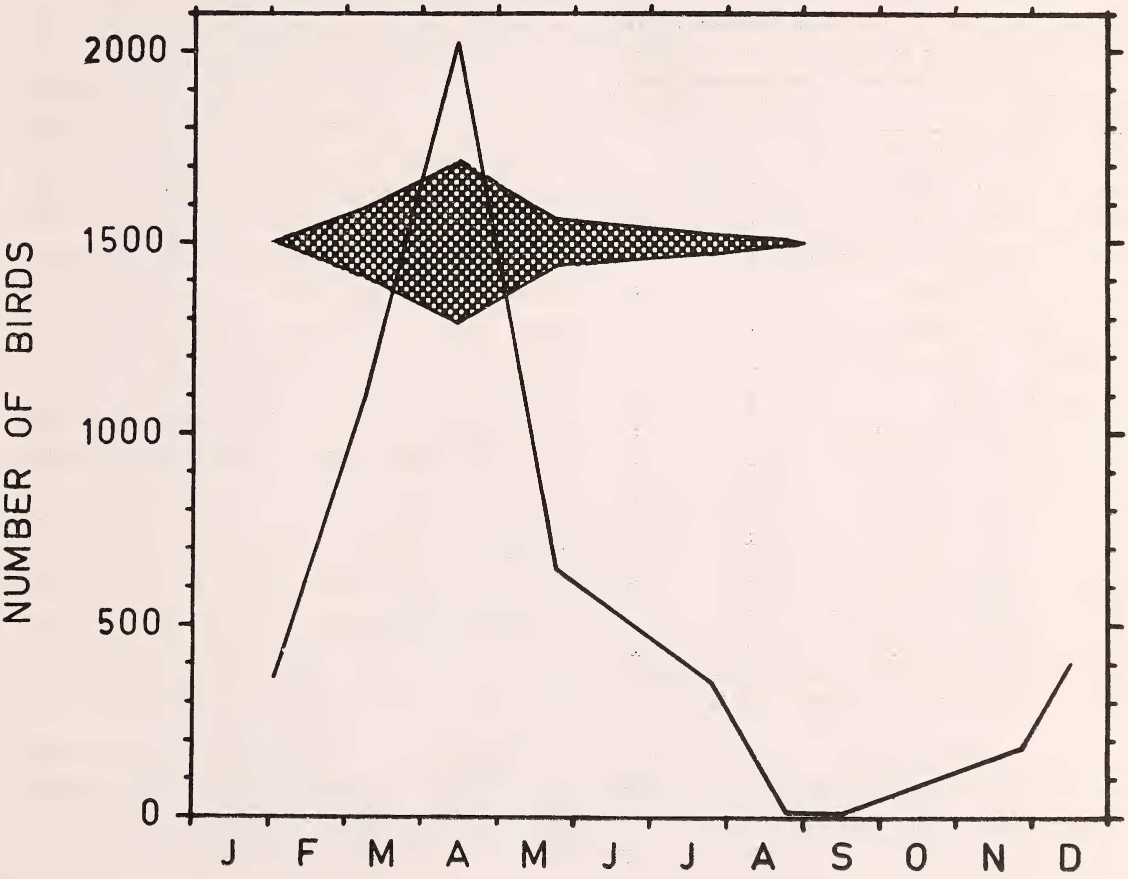


Fig. 1. The number of Indian Reef Heron roosting in relation to the timing of breeding season at New Port. The curve shows the number of birds roosting on different dates. The area covered by crossing lines indicate the proportion of pairs engaged in nesting activities (nest-building, incubation and feeding chicks).

were existing at both the heronries and the herons readily used them. At Gogha, an old nest of the House Crow was also occupied after repair.

The nests were usually placed in the vertical forks of three to four branches on the outer periphery of the tree crown. There was no foliage cover over many of the nests. In April and May, when the leaves of the Peepul and Peeper trees (Table 1) were shed, all the nests were almost totally exposed to the sky. Number of nests per tree depended upon number of branch forks available on the tree. On a big Peepul tree more than a hundred nests were accomodated, as there were many branch forks available for nest-building.

TABLE 1

DIFFERENT TREE SPECIES USED FOR NESTING BY THE INDIAN REEF HERON AT NEW PORT AND GOGHA

Plant species	New Port[1]	Gogha[1]
Albizzia lebbek, Lebbeck-tree	x	x
Avicennia marina, Mangrove	x	
Azadirachta indica, Neem	x	x
Casuarina equisetifolia, Casuarina	x	
Ficus amplissima, Peeper	x	x
Ficus benghalensis, Banyan	x	
Ficus racemosa, Cluster Fig	x	
Ficus religiosa, Peepul	x	x
Mimusops elengi, Spanish-cherry		x
Prosopis juliflora, Mesquite	x	x
Sapindus laurifolis, Soapnut		x
Syzygium cumini, Jambul	x	
Tamarindus indica, Tamarind	x	x
Thespesia populnea, Portia tree	x	
Zizyphus mauritiana, Jujube	x	x

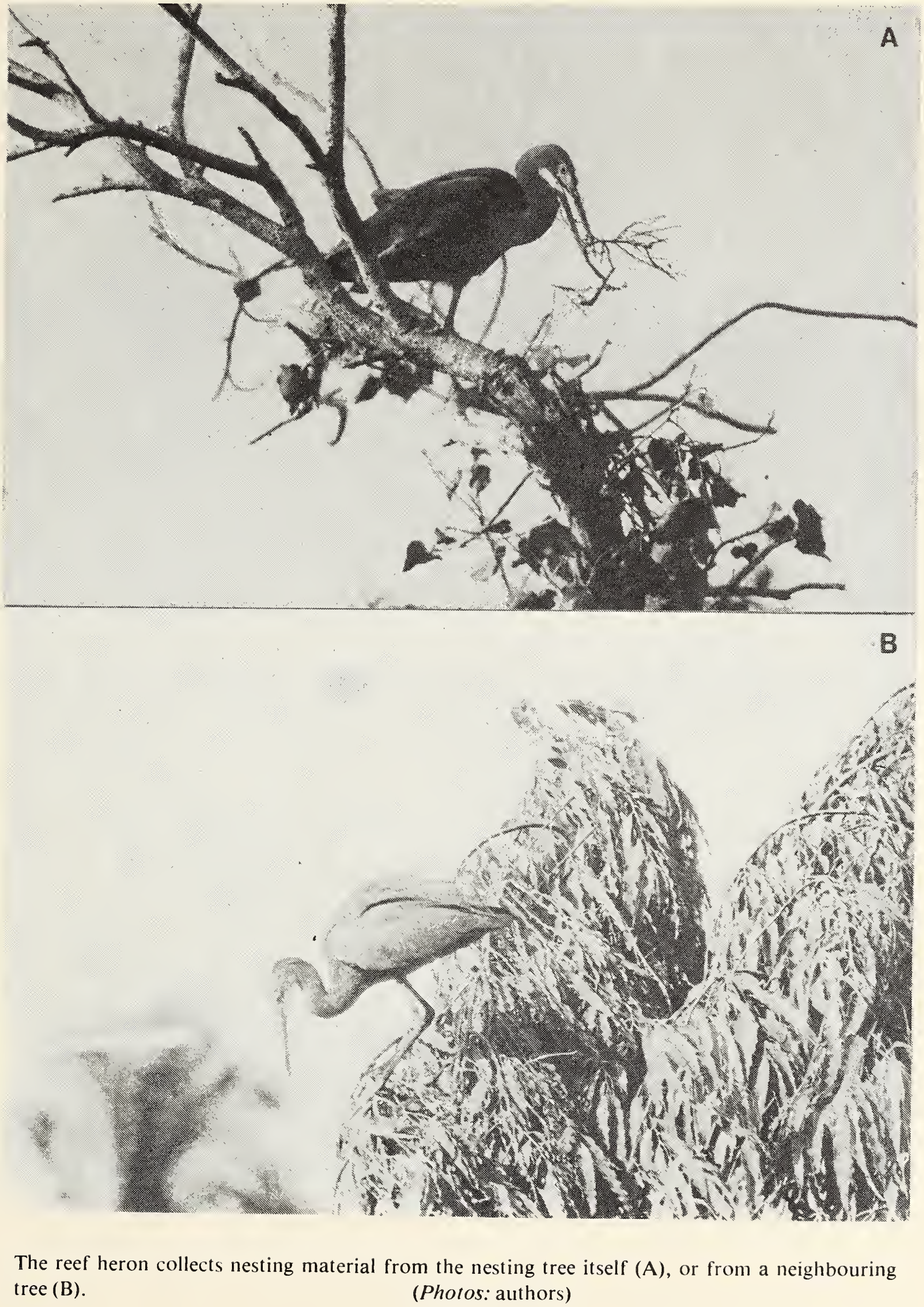
[1] Use of a tree species is marked with x.

In a few nesting pairs where the sexes of the birds were known, the nest material was collected by the male and actual building was done by the female. Similar observations are reported by Ali and Ripley (1968). Such a division of labour during nest building has also been recorded in the Little Blue Heron, *Florida caerulea* (Meanly 1955); Cattle Egret (Blaker 1969); Indian Pond Heron, *Ardeola grayii* (Lamba 1963) and Night Heron (Ali and Ripley 1968), Blaker (1969) thought that the system of division of labour might have arisen so that the nest could be permanently guarded.

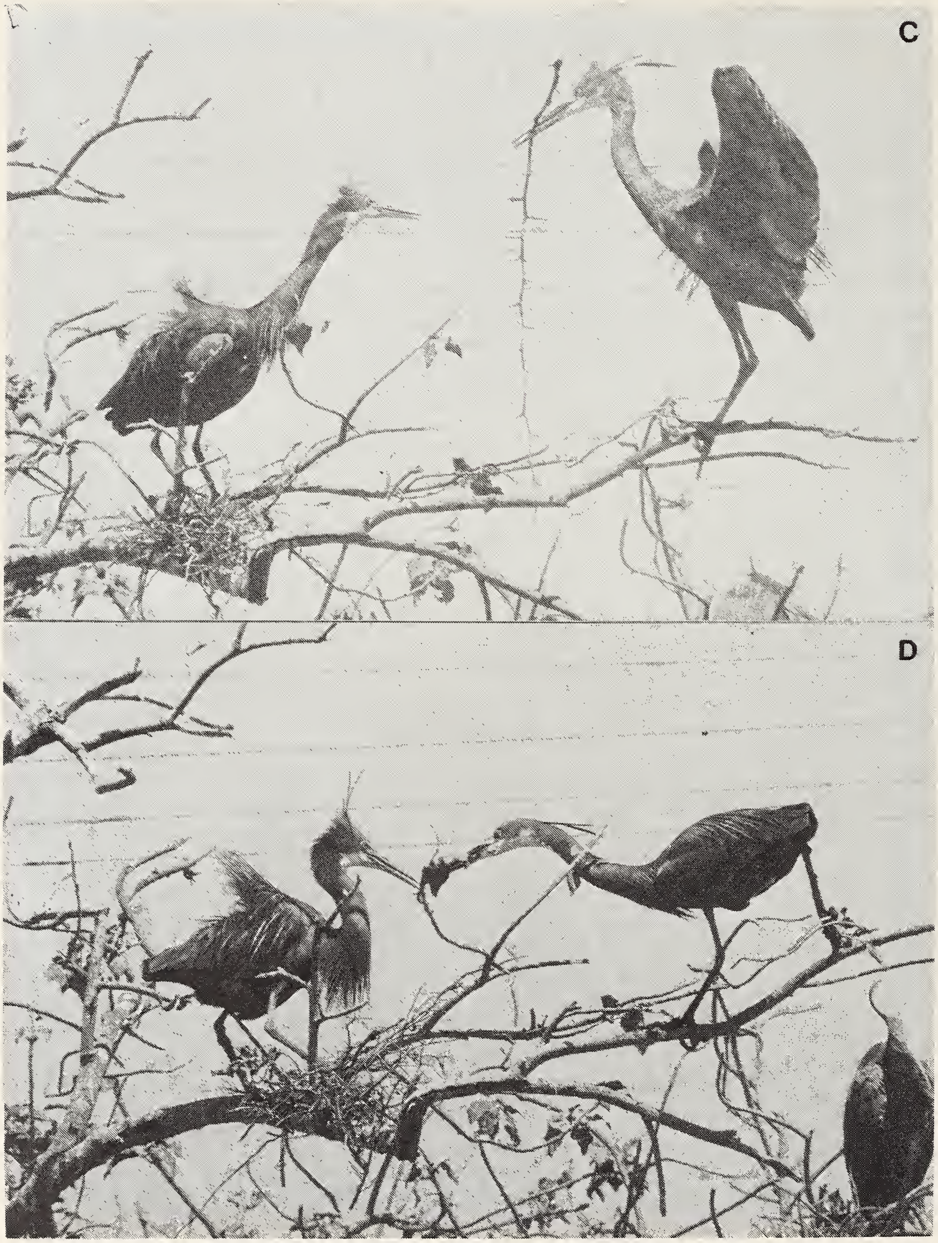
The nests were platform type, built mainly of dry and brittle sticks ranging from 12 to 66 cm length. Green twigs and pliable twigs were occasionally used. Generally, the nest material was collected from open ground nearby, but occasionally the bird pulled out branches from the nesting tree itself (Plate 1, A) or a neighbouring tree (Plate 1, B). One nest from Gogha analysed in August, 1980, comprised of 210 twigs mainly of the Peeper (*Ficus amplissima*), Neem (*Azadirachta indica*), Jharber (*Zizyphus nummularia*), Caper (*Capparis decidua*), Rusty shield-bearer (*Peltophorum pterocarpus*), Sickle senna (*Cassia tora*) and some grasses. The nests were usually lined with small twigs. Contrary to the Gogha nests, the New Port nests were chiefly constructed of thorny twigs and dry branches of Seepweed (*Suaeda nudiflora*) and in some cases, eggs were laid without lining the nests.

Mean measurements of eight nests at New Port in 1982 were: outer diameter about 35 cm, inner diameter about 18 cm and depth about 4 cm.

The addition of nest material continued throughout the incubation period, but stopped almost completely when the chick hatched, as Blaker (1969) observed for the Cattle Egret. In two cases, the nest material was added even after the chicks hatched. Pratt (1970) also observed occasional twig presentation in the Great Heron after a part of the clutch had hatched.



The reef heron collects nesting material from the nesting tree itself (A), or from a neighbouring tree (B). (*Photos:* authors)



Male reef heron returns with nesting material (C), and presents it to the female (D).
(*Photos:* authors)

After selecting a nesting site, the pair remained perched there for a few hours courting each other. Ultimately copulation occurred right there. After the male dismounted, both the birds held a small nearby branch and shook it vigorously. Thereafter, the female remained perched on the site and the male flew off to collect nest material. The male returned with a twig (Plate 2, C) and greeting ceremony followed. The male presented the twig to the female (Plate 2, D), which tried to arrange it on the branch fork, but the first few twigs fell to the ground. Sometimes, a pair could not arrange a few twigs on the site even after 24 hours of effort. Later on, the twigs were arranged criss-cross in the fork by shaking the twigs sideways ("Tremble shoving" — see Meyerriecks 1960) and by pulling and pushing them. As soon as the platform was prepared, some small thin twigs were added to it as lining material. During nest building, a considerable amount of nest material fell out of the nest, and occasionally the bird flew down to collect material lying under the nesting tree.

Intraspecific stick stealing from an unguarded nest was observed in many cases. The stick stealing birds could dismantle an unguarded nest within a day or two, and they even ejected the eggs or chicks in the process. Chances of losing nest-material from a nest increased progressively during the nesting period when the nesting pair started leaving the nest unguarded over a longer period. In one case at Gogha, a nest-building pair attacked the chicks in an unguarded nest and started pushing them away. After several attempts, the pair succeeded in driving away the chicks and occupying the nest, in which after an addition of a little more material, the pair raised its own brood successfully. The chicks which were evicted from the nest remained perched on nearby branches and they were fed there by their parents until they fledged. Intra-specific stealing of nest material was observed for Cattle Egret by Valentine (1958) and Blaker (1969) for the Great Blue Heron by Pratt (1972) and Mock (1976), and for the Great White Egret by Mock (1978).

The nests were built at a height of about 5 to 15 m from the ground at Gogha, but some nests were built even at the height of about 2 m from the ground at New Port. The species of trees used for nesting in Gogha and New Port are given in Table 1.

EGGS AND INCUBATION

Egg laying:

Generally the eggs were laid at an interval of two days, but in two cases the interval was longer than three days. In this connection, a case history of one particular nest is worth noting. The first egg was laid on 29 February, and the second on 2 March. On 5 March, a third freshly laid egg was found, but the first two eggs were missing. On 14 March, when the nest was checked, the third egg was missing but two new eggs were added in the nest. Again on 25 March, when the nest was checked two more eggs were found, so that there were now four eggs in the nest. Including the loss of three eggs earlier, the bird laid a total of seven eggs during an 18-day period. It is possible that, after having lost all the eggs of the first clutch started on 29 February, the bird started a fresh clutch around 12 March; this speculation is based on the observation that the two eggs found on 14 March were fresh in appearance.

Incubation:

The first egg was laid within 4 to 7 days after the initiation of nest-building. As in all Ardeidae (Kendeigh 1952), the incubation began with the laying of the first egg. Once the eggs were laid, the nest was never left unattended in summer except during a big disturbance. In monsoon, however, the birds often left the nest unguarded (Plate 3, E) even if there was no disturbance. Incubation period (interval between the laying and hatching) of only two eggs was precisely known and it was 23 and 24 days.

Both the sexes participated in incubation. Generally, there were three change-overs of duty within 12 hours of the daytime, but occasionally there was only one change-over in the morning for the whole day. The duration of the attentive period varied between 2 and 8.5 hours. Both the sexes attended the nest and their average attentive period had about the same duration. The nest was attended at night by any one sex. In one case, a bird covered the eggs continuously from 1200 to the next morning, which added up to more than 20 hours of nest attendance.

Clutch and egg size:

Clutch size is defined here as the total number of eggs known to have been laid in a nest in an uninterrupted series. The clutches of 3 and 4 eggs were most usual (as also stated by Ali and Ripley 1968) but occasionally a clutch of 6 was also laid. Our data on the size of 28 clutches are summarised in Table 2.

Fresh weight (weighed within 24 hours of laying) of 22 eggs and dimensions of 88 eggs are summarised in Table 2. Baker (as quoted by Ali and Ripley 1968) measured 50 eggs and reported the average size as 44.9 × 34.3 mm which was close to our measurement.

Egg mortality:

Falling out of the nest was the main cause of egg loss. In certain cases, the heron started laying even when the nest platform was not completed. In such nests, a heavy egg loss occurred during the laying period. Occasionally, when an observer climbed a nesting tree for nest-checking, the birds left their nests in a hurry, shaking the branches supporting nests, and this, in turn, caused eggs to fall out of the nests. During such a disturbance, the House Crow did not miss a chance to take away the eggs. This predator tried to take away the eggs and small chicks at other times too, when the nest was unattended. During May to July, very high winds in the afternoon and evening also caused egg-fall. Intraspecific nest-material stealing activities were also a factor for egg mortality. The White Ibis, in an attempt to appropriate some active nests of the reef heron,

TABLE 2

CLUTCH SIZE AND EGG SIZE OF THE INDIAN REEF HERON AT GOGHA, SUMMER 1980

Clutch size[1]			Egg size[2]		
Size	Frequency		length mm	width mm	weight g
3	10	Range	41.5 to 50.2	30.4 to 35.7	23.0 to 31.5
4	16		(88)	(88)	(22)
5	0	Mean	45.61	32.97	28.39
6	2	s. d.	2.030	1.069	2.262

[1] Mean clutch size ± s.d. = 3.8 ± 0.79 (for clutches).

[2] Numbers in parentheses indicate the number of eggs measured.

destroyed the herons' eggs and chicks at New Port.

Chicks

Hatching:

Chicks hatched asynchronously. The eyes of the chick were open and the body covered with down at hatching. The down dried up within a few hours. The empty egg shell was ejected out of the nest by the attending parent.

Mortality:

The chicks of 18 days or more were left unguarded by the parents. The chicks roamed out of the nest after the age of 24 days, so that it became difficult to determine as to which nest they belonged to, and in many cases the fate of nestlings after 24 days could not be recorded. Therefore, 24 days was considered as the nestling period, at the end of which the chicks were considered to have fledged. Mortality rate decreased after the chicks fledged, as only a few fledged chicks died before they left the colony. Such deaths were chiefly due to a fall from the nesting tree.

Predation by the House Crow was one of the major factors leading to chick mortality, particularly during early (less than 10 days) age. Chicks older than 18 days, which usually wandered out of the nest, often lost their balance, fell to the ground and died. They often went too close to the neighbouring nests, where the attending parents did not tolerate their trespassing and tried to stab them. During such encounters, the chicks got injured, often lost their balance and fell to the ground. On being frightened by a human climbing a tree, the chicks tried to run away and fell to the ground.

Mortality of chicks due to starvation did not appear to be significant during an earlier part of the season; 7 broods, each one of 3 chicks, were reared without any chick loss and in one case four chicks were reared without a loss. But during the later part of the season, the younger chick in many broods died due to starvation. Except for the House Crow, no other avian predator was observed in the colony. The domestic cat was reported to climb nesting trees and kill the chicks at night at New Port.

The chicks which accidentally fell to the ground generally died due to the fall. Even if they survived, they could not climb back to their nests. Such chicks were then killed by domestic dogs.

Chicks also fell out of the nests when heavy wind, storm or rain prevailed. Some chicks were found hanging dead from the nest rim after a heavy wind had blown. Some chicks died because one of their legs got trapped in a narrow branch fork.

Asynchronous hatching:

In a usual brood of three chicks, two older ones were very big as compared to the youngest. The youngest chick apparently stopped growing for a long time and remained in the nest even when the older ones were roaming around the nesting tree. This difference in the growth of chicks was due to their asynchronous hatching. The eggs hatched in the sequence in which they were laid. Therefore, the age difference between the eldest and youngest chicks in a brood was quite often more than five days. The parents fed the older chicks which begged violently; the younger chicks got less food, they remained smaller for a long time and sometimes even died due to starvation.

Parental care

Guarding the nest:

At least one parent actively guarded the chicks (Plate 3, F) till they attained the age of about 18 days (average for five nests). After that, a parent took up a perch some distance away from the nest and guarded the chicks for a further period of two to five days. Thereafter, the chicks were left unguarded, and the parents returned to the nests only to feed them and to roost with them at night.

The full "Forward display" was directed by an adult bird towards a predator, a conspecific perching very close to the nest or even a human intruder. If the crow was very close, the guarding bird might stab towards it. When an observer climbed a nesting tree for nest-checking, the adult birds flew over to branches further away, and kept an eye on the observer from there. Often they produced a short "Kok-kok" alarm call and maintained an alert posture. Only in a few cases did the guarding bird not leave the nest and violently attacked the observer's hand when he tried to pick up chicks from the nest.

A guarding adult did not permit any heron other than its family to perch close to its nest. An intruder was threatened with the Forward display, or even chased some distance away. In one case, a guarding bird was threatening a courting pair perching very close to its nest, when a guarding bird from another nearby nest rushed to the courting pair and chased it away. Trespassing neighbour-chicks were also attacked and stabbed on their head. Chicks which accidentally fell on the ground were not cared for by the parents.

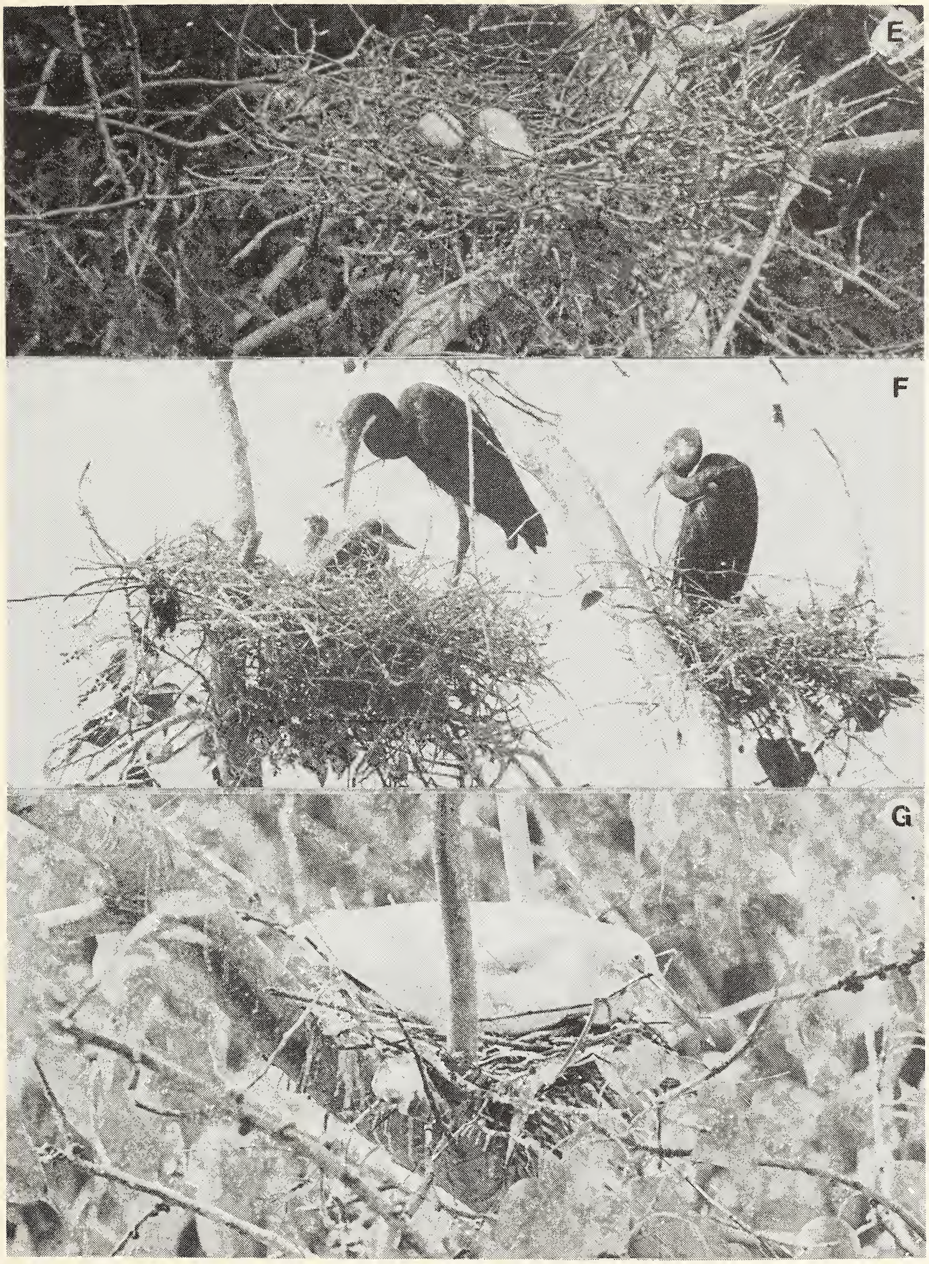
Thermoregulation:

Generally the herons incubated the eggs or brooded the chicks by sitting on them. The sitting bird kept its feathers fully depressed (Plate 3, G) or partially raised to conserve its body heat and kept them fully raised (Plate 4, H) for passage of air for dissipating the heat. The incubating bird might keep its neck straight, let the head rest on the nest rim and doze off from time to time.

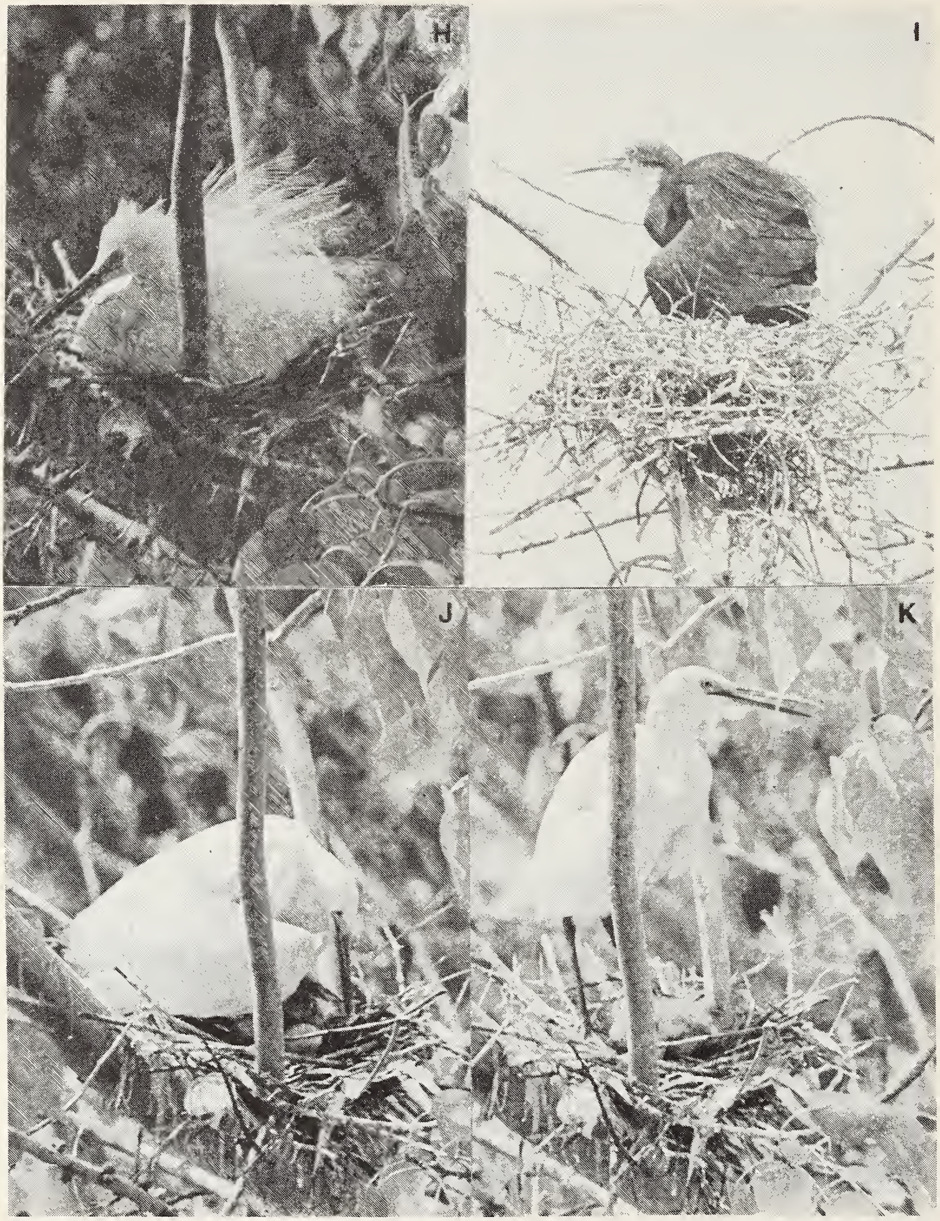
The chicks were highly susceptible to direct radiation from the sun, especially when the ambient temperature rose up to 42°C in April/May, and there was a special need to prevent the chicks from getting over-heated. Assuming a posture very similar to the Delta-wing posture of the storks (Kahl 1971), the reef heron kept its wings in a drooping position, kept its back towards the sun and shaded the chicks with the wing canopy (Plate 4, I) During the hot hours, almost all the guarding birds in a colony could be found facing the same direction. The direction of the guarding bird changed with the position of sun. In April-May, this directional thermoregulation started right at 0900 and could be seen till 1700. The parents shading the chicks stood on the rim of the nest, often keeping the legs flexed (Plate 4, J). The back feathers were often raised. The beak remained open and gular fluttering continued (Plate 4, K). The chicks kept themselves under the parent's shade, often touching the parent's body. Blaker (1969) did not find any special shade-providing position in the Cattle Egret, but Jenni (1969) has reported it in the Cattle Egret as well as in a few other species of herons.

The adult birds started gular fluttering from 0900 and continued till 1830 in April-May. As the adult birds were also susceptible to the sun's heat, it seemed that the wing posture had not only the function of shading the chicks, but also gave passage to the wind to pass through and helped the bird in self-thermoregulation. Kahl (1971) suggested that it is probable that the function of shading the nest contents is often combined with self-thermoregulation in birds adopting the spread-wing posture over eggs or young in hot weather.

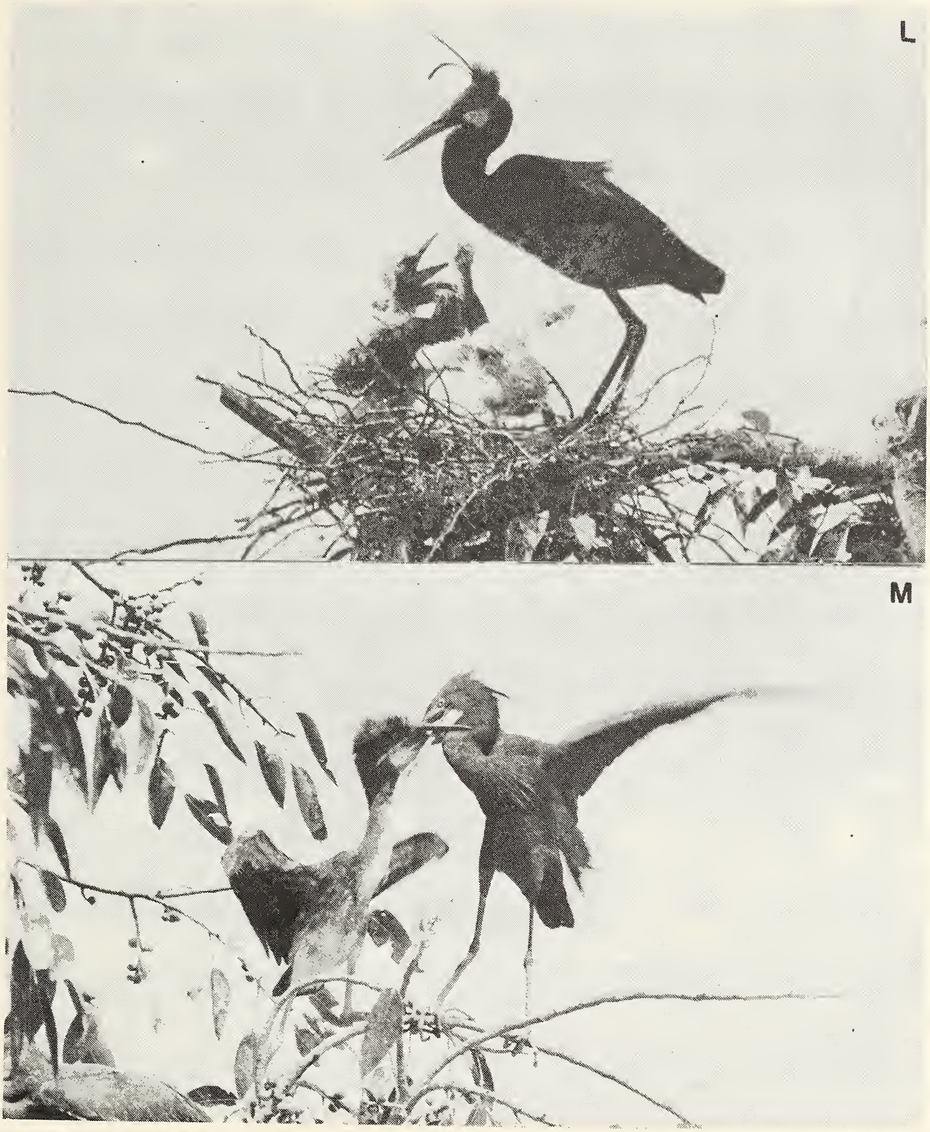
One-day old chicks had the gular fluttering ability. Though brooded and shaded by the



The reef heron's eggs are occasionally left unattended in monsoon (E), but the small chicks are always attended to (F), and are brooded from time to time (G).
(*Photos:* authors)



The reef heron, while shading its eggs and chicks from solar radiation, often raises its feathers fully (H), and resorts to gular fluttering (I), to dissipate its own body heat; by spreading its wings partially the bird forms a canopy (J, K) over its brood and at the same time dissipates its own body heat. (*Photos:* authors)



Food soliciting behaviour of the heron chicks changes with age (L, M).
(*Photos:* authors)

parents, the gular fluttering apparently helped the chicks in self-thermoregulation.

Feeding the chicks:

Freshly hatched chicks responded to tactile and auditory stimuli. They tried to stand erect on their weak legs with the support of the bulging abdomen, raised the beak and gave short 'Chik-chik' call. They pecked a moving object and also the nest floor. The adults regurgitated food on the nest floor, and the chicks in early stages pecked and ate it. The chick even pecked the parent's beak as it regurgitated. If the regurgitated food items were too big for the chicks to swallow, the parent reconsumed them. As the chicks grew older, the 'Chik-chik' call became louder and was accompanied by a sideward rocking movement of the body, with the wings partially opened and held horizontally (Plate 5, L). The older chick grabbed the parent's beak and pulled it down violently to make the parent regurgitate, and since the chick grabbed the parent's beak across the base (Plate 5, M), regurgitated food passed directly to its beak. If the parent's beak was not grabbed properly, the food fell down upon the ground. Often, the House Crow actively waited for such a situation and disturbed the feeding adult to get the fish. Under the nesting trees, even dogs waited for the fish to fall down. When a chick was fed on a slender branch, both the parent and chick kept on beating their wings to maintain their balance.

The older chicks had a greater chance of getting food than the younger ones. As the chicks started running out of the nest, they often chased the parent on branches of the same tree or a nearby tree. For some time even after the chicks started roaming around, the parents continued to come to the original nest-site to feed them. The older chicks could recognize their parent when it was a few metres away. But some chicks wrongly identified an adult as their parent and started begging for food. As the chicks aged more than 24 days, the parents avoided them even though they had come to feed them. The parent alighted on the nest-site, looked around, sometimes chased away the neighbour chicks roaming around, and then only fed their own chicks. Avoidance of chicks by the parents might have increased the probability of successful feeding of the younger chicks that had still not left the nest. Secondly, avoidance might have stimulated the chicks to start flying around and ultimately leave the colony. Some juveniles, which could fly freely but had still not left the colony, actively searched for food fallen on the ground. Some of them also fed on house flies sitting on the ground. We have seen a juvenile standing on an elevated ground catching dragonflies flying around, directly from the air ("Standing flycatching" — see Kushlan 1978). Some juveniles were seen following their parents on the feeding ground and begging for food, but we do not know whether the chicks were ever fed there.

RE-NESTING

The reef heron made a fresh nesting attempt if it lost its eggs or young early in the season. A pair lost its complete brood in March, but it remained in the nest and laid a second clutch within eight days; this nesting pair and its nest was under continuous observation for recording the soft-parts colour changes and the individual birds could be recognized by their distinctive physical features. Such re-nesting is also observed in the Green Heron (Meyerriecks 1960) and in the Great Blue Heron (Pratt 1970). In some cases, after the loss of the first one or two eggs, the herons deserted the nest; possibly they nested elsewhere.

BREEDING PERFORMANCE OF SOME SELECTED PAIRS

Table 3 summarises the breeding performance of 28 pairs whose nesting resulted in hatching of at least one chick at the New Port heronry. The clutch size is the number of eggs laid in an uninterrupted series. The number of eggs lost during incubation were those that fell out of the nest or were predated during the incubation period. The eggs that failed to hatch were those that survived the incubation period, but failed to hatch either because they were not fertilized, or because the embryo died before completing development. The hatchability of eggs is the number of eggs hatched/ number of eggs surviving the incubation period. The egg mortality is the number of eggs lost plus those that did not hatch/total number of eggs laid. The hatching success is the number of eggs hatched/total number of eggs laid. The initial brood size is the number of chicks hatched per nest. The chick mortality is the number of chicks lost before fledging/total number of chicks hatched. Nesting success is the number of chicks fledged/total number of chicks hatched. The number of chicks fledged per nest is the number of chicks surviving until Day 24 per nest.

TABLE 3

A SUMMARY OF THE BREEDING PERFORMANCE OF THE INDIAN REEF HERON

(Number of nests sampled = 28)

	Mean± s. d.
Clutch size	3.8± 0.79
Eggs lost during incubation (%)	13.1±16.73
Eggs failed to hatch (%)	11.9±17.03
Hatchability of eggs (%)	86.3±21.19
Egg mortality (%)	23.8±18.25
Hatching success (%)	77.5±16.28
Initial brood size	2.9± 0.76
Chick mortality (%)	33.1±33.27
Nestling success (%)	67.9±33.27
Number of chicks fledged/nest	1.9± 1.02

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RODENT CONTROL BY IRULA TRIBALS[1]

ROMULUS WHITAKER[2] AND M. MURALI[3]

(*With two plates and two text-figures*)

Rodents have proved to be man's most common, persistent and destructive vertebrate competitor, in many circumstances managing to destroy more food crops and stored food than all the other pests combined. Control of rodents has been mainly limited to using rodenticides which are often ineffectual and are harmful to non-target animals, man and the environment.

This paper describes the formalisation of an old approach to rodent control: direct capture by skilled Irula tribals. The Irula methods, results and cost effectiveness are presented. Collaboration by the tribal Cooperative with Government and private agencies concerned with vertebrate pest control is recommended.

THE RODENT PROBLEM IN INDIA

A. *Rodent populations*

Various authors have made estimates of rat populations in India. Srivastava (1975), using average figures of 2-3 rats per acre and 300 to 700 per village estimates nearly 5 billion rats for the entire country, more than six times the human population. The same author quotes a figure of 11 million tons of foodgrains eaten and damaged by rats annually in India.

Rodent populations in rice fields average from 5 to 25 per acre (Rajasekharan and Dharmaraju 1975), usually depending on the time of year in relation to harvest. However, during rodent "flareups" mouse populations have shot up to as high as 80,000 per acre (Pingale 1985).

B. *Damage*

In one study in Rajasthan, Prakash (1976) reports that desert gerbil (*Meriones hurrianae*) populations in one fodder growing area averaged over 160 per acre. Their yearly food requirements were 420 kg/acre, while the year's production of fodder amounted to only 490 kg/acre. In the same State, it was estimated that desert gerbils excavated soil resulting in erosion at the rate of 250 kg/day/acre

Adult rats consume about 5% (for the greater bandicoot) to 20% of their body weight in food per day, which amounts to an average consumption of about 20 gms per day for the species most commonly infesting paddy fields. Srivastava (1975) estimates 10-50% crop losses due to rodents depending on the crop and several other factors. Losses are often highest in paddy. In addition to causing immediate loss by consumption of grain and damage to rice plants and bunds, the lesser mole rat (*Bandicota bengalensis* — the main rice pest in the area of this study) is a most efficient hoarder. In one study in Pakistan, Greaves *et al.* (1975) reported lesser mole rats storing grain at the rate of 40 kg per acre (2.5% of the crop). Prakash (1976) states that hoarding by this species can be as high as 180 kg per acre. Irulas working on this project have

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shown quantities ranging from one to seven kilograms of groundnuts, rice and ragi recovered from individual lesser bandicoot burrows. The second stage of the Irula rat control project will address itself to this important aspect of rodent damage and its correlation with overall damage to standing crops.

Frantz (1975) makes the point that over 30,000 humans are added to India each day and the majority are rice eaters. A population of 200 lesser bandicoot rats in a single large rice storage godown can consume enough rice to supply an average Indian for eleven years. In one godown in Calcutta, losses were estimated at over 4000 kg per year. His important contention is that saving food already grown can be a more effective answer to food shortage than growing more food.

C. *The unintegrated approach*

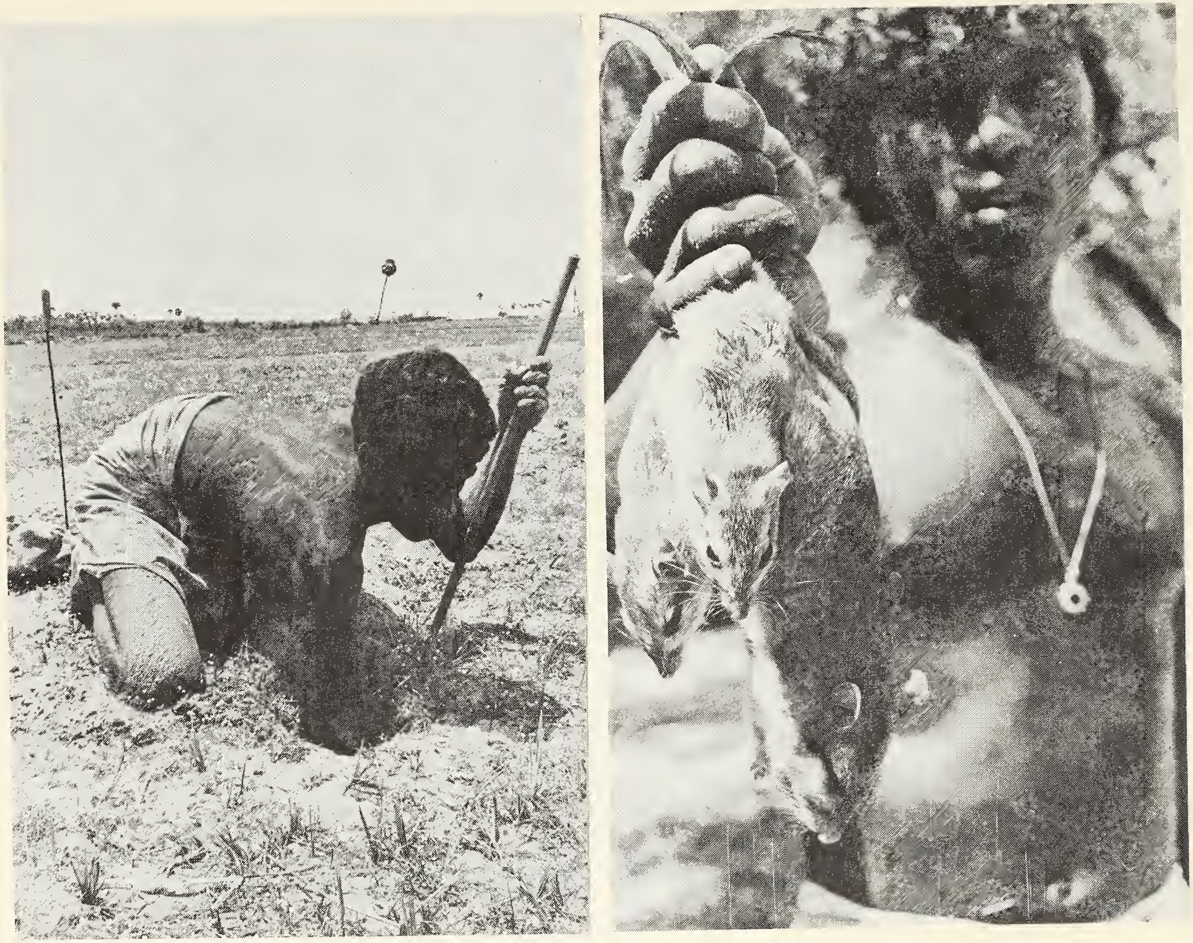
In India rodent control is synonymous with pesticide use. Tons of aluminium phosphide, zinc phosphide, warfarin, calcium cyanide, strychnine and other rodenticides are sold and distributed throughout towns and farmlands every month. There have been several international symposia on rodent control in India. If the 1975 Ahmedabad meeting is typical, the questions of alternatives such as biological control and capture of rodents by employing local people do not even deserve a mention. Similarly, natural predation by snakes, birds of prey and other predators is generally dismissed, as being of little consequence though recent findings indicate that snakes play a considerable role (Whitaker and Advani 1983). At the same time the integrated approach to rodent pest management is acknowledged to be the best approach and one would hope that directions other than rodenticides were examined.

The human and animal risks and environmental costs of reliance on the use of pesticides are rarely given more than a passing reference, and data on secondary poisoning and overall risk are never presented. Statements by the 1975 symposium participants are sometimes disconcerting. For example, C. R. Madsen (former USAID Vertebrate Pest Control Adviser) says "Rats (killed by poisons) improperly disposed of have caused accidental poisoning of dogs, hogs and sometimes jackals and kites". A bit later, in the same symposium P. D. Thaker, Chief Officer, Sidhpur Municipality makes the following confessions: in one project 5.5 tons of poison baits were distributed in Sidhpur and a total of 13,000 dead rats counted. Another 40,000 rats were reported dead though not seen by project staff, and thrown away by towns people and, in his words, "might have been picked up by predators like birds and dogs and eaten away". N. S. Rao (1975), the Managing Director of Pest Control India Ltd., states "Most of the rodenticides currently in use here and elsewhere are highly toxic not only to the rats and other closely related orders, but to the entire class of mammals".

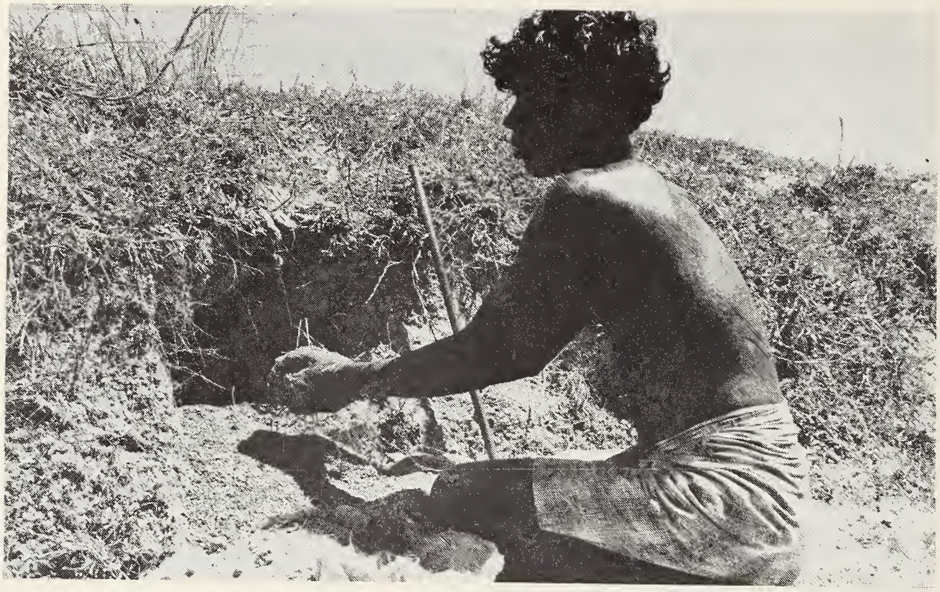
But the "traditionalist" rat control researchers are certainly aware of the shortcomings and danger of chemical rat killers. They acknowledge that the search should continue for the ideal integrated approach. Unfortunately we have fallen for the western pesticide package with as much fervour as rats go for rice. It may take us awhile to unlearn what almost amounts to an obsession with chemicals, but it is evident that awareness is growing. Rodentologist S.C. Frantz (1975) aims the following statement at India: "Low cost, labour intensive, culturally adapted technologies are needed for long term solutions to such problems as rodent depredations".

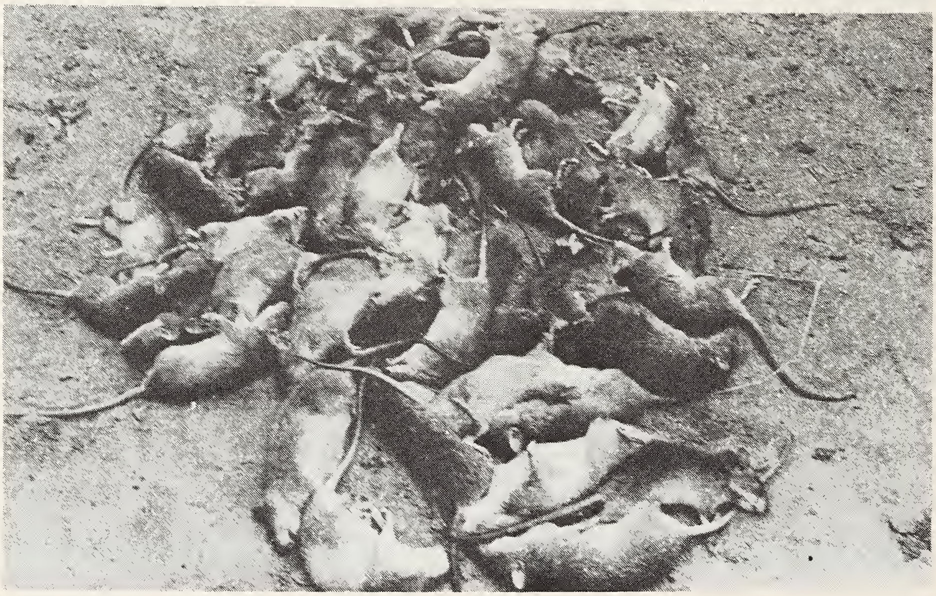
PROJECT OUTLINE

This paper describes the results of fifty six



Left: Irula digging for rats in fallow land near Madras.
Right: An Irula with his catch of Gerbils.
(*Photo:* S. Dattatri)





Above: Stored grain in a lesser bandicoot burrow.
(*Photo:* S. Dattatri)

Below: A mornings catch of rats.
(*Photo:* Rajendran)

rodent control field trials undertaken by the Irula Snake-catchers Cooperative in Chingleput District during 1985-86. It had been decided, at the inception of the Cooperative in 1978, that one way to employ a large number of Irulas (an underprivileged community designated by Government as a Primitive Schedule Tribe) is to organise them to control rodents by their expert, traditional methods. There are 28,000 of these plains tribals in Chingleput District of Tamilnadu alone. Rodents are undeniably the most destructive vertebrate pests on earth. The problem in India is especially acute, with a significant percentage (estimates under different circumstances range from 10-50%) of standing and stored foodgrains and other crops being destroyed by rodents each year.

In 1984, Oxfam (India) gave the Irula Cooperative a grant to carry out field trials in order to establish the cost effectiveness of Irula methods in controlling rodents. Two key arguments are evident in favour of this approach to pest management: (a) it employs Irulas, a group of economically depressed people with little recognition of their considerable skills, (b) it makes no use of deadly pesticides with their costs, both monetary and environmental.

In 1976, a field trial using Irula methods was carried out at the Central Food Technological Research Institute, Mysore. Rodentologists from Central Plantation Crop Research Institute, Kasaragod, Kerala also witnessed the Irula rodent control approach. In the present study, field trials number 1 and 2 were carried out at the request of the Tamil Nadu Agriculture Department in the presence of 100 village Field Officers.

A. *Methods*

Irulas have traditionally caught rats for many generations as a supplementary food source (almost all species are eaten, and some are quite tasty). They have thus developed a knowledge of rodent habits that is unsurpassed. Using these skills they can locate "live" burrows (i.e. those which have rats in residence) and quickly capture the occupants. They use two basic techniques for their rat capture: direct digging of the burrow with nets over or next to exit holes particularly for the gerbil (*Tatera indica*); smoking them out (often used where digging is impractical or impossible, like under house foundations).

The Irula rat catching programme (under the title R.A.T.S. — for Rodent and Termite Squad) generally operates by sending teams of three or four Irulas with a team supervisor to a farm, godown or residence. The team spends as much time as it takes to cover the area under contract and systematically removes all rats by digging and smoking them out. Burrows are destroyed and the farmer or house owner advised on rat control measures such as clearing piles of stones and rubbish and calling *RATS* for regular, quarterly visits.

In the case of more affluent farmers and home owners, a fee was charged for the rat catching service. For poorer village farmers, the control was done free of charge in the interest of data collection for the field trial and to establish the *modus operandi* for a proposed, large scale Irula rodent control scheme. During this study, about 20% of the farmers and land owners were not willing to let the Irulas dig into the bunds around the rice fields, the most important single constraint encountered.

In this study, the costs of controlling the rodents are considered to be the wages paid to the Irulas and their transport costs. The salary of the supervisor, to record and compile the data is paid by the project but is not considered a part of the cost of rodent control.

B. *Results*

Mainly between November, 1985 and July, 1986 (nine months) fifty-six rat catching field trials were undertaken in Chingleput District, Tamil Nadu. A total of 278 Irula man-hours were utilised to capture 2131 rodents for an average of 7.8 minutes per rodent. At an expenditure for Irula wages and transport of Rs. 3500/-, the cost of catching each rat was Rs. 1.65.

Irulas are paid Rs. 20/- per day for rat catching. A supervisor was employed by the rodent programme for 744 man-hours (93 days) to obtain contracts, supervise the fieldwork and compile results. A summary of the 56 field trials, including costs is given as Table 1.

TABLE 1

SUMMARY OF 56 IRULA RODENT CONTROL FIELD TRIALS

1.	Area worked (acres)	234
2.	Total number of burrows dug up	1133
3.	Rodents caught	2131
4.	Number of rodents per acre	9
5.	Hours spent in the field	278*
6.	Average number of Irulas in field trials	3
7.	Irula man-hours spent in the field (278×3)	834
8.	Wages paid to Irulas (Rupees)	3283/–
9.	Transport costs	252/–
10.	Cost of control per rodent	1.65
11.	Cost of control per acre	15/–

* 218 hours in rice fields, dry farms and bunds, 60 hours in sheds, dwellings and godowns.

About 234 acres of land were covered in the present trials for an average of nine rats per acre. Each rat consumes about 20 grams of foodgrain per day and may destroy more than twice that amount each day. In addition to this loss, one species of rat, the lesser mole rat, (*Bandicota bengalensis*) may store large quantities of grain for the lean season and for its young. In the present trials, 4 kg of grain was recovered from one rat burrow while the average quantity was 2.1 kg for each hoarding *B. bengalensis.* However, as some of the trials were not in the harvest season and some in non-rice or grain habitats such as chicken farms, a high yield of stored grain was not expected. Fig. 1 is a graph of average numbers of rats caught per trial. It is obvious that numbers are highest in the harvest season and lowest during the pre- and post-harvest months.

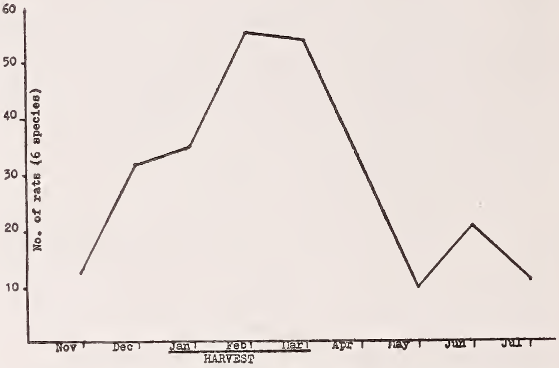


Fig. 1. Average number of rats caught per trial.

In one series of rice paddy bund trials in this study (four days in January), 3000 metres of bunds were hunted and 344 rats caught at an average of one rat for every 8.7 metres of bund. In another series of three trials carried out at an average of 64-day intervals at one farm, the number of adult rats caught in the first trial was 31 (Table 2). In the third trial, five months later, only 8 adult rats were present. This indicates that control visits should have an interval of two months or preferably less, and varying according to the local crop pattern.

C. *Cost benefit*

The purpose of ridding a farm, godown, shop or dwelling of rodents is to save crops,

TABLE 2

PATTERN OF RODENT POPULATIONS AT A FARM VISITED FOR RODENT CONTROL AT TWO-MONTHLY INTERVALS IN CHINGLEPUT DISTRICT

Rodent	1st Trial (20.12.85)			2nd Trial (28.2.86)			3rd Trial (18.5.86)		
	Adult	Juv.	Total	Adult	Juv.	Total	Adult	Juv.	Total
Bandicota indica	12	–	12	–	–	–	–	–	–
Bandicota bengalensis	4	–	4	4	–	4	4	–	4
Tatera indica	4	–	4	–	–	–	1	–	1
Rattus spp.	9	–	9	4	10	14	1	8	9
Mus spp.	2	–	2	10	–	10	2	–	2
Total	31	–	31	18	10	28	8	8	16

food and property from damage. Whether rats have eaten a kilo of rice, chewed a hole in a valuable sari or gnawed a power line and caused a dangerous short circuit in an atomic power plant, their damage is costly at all levels. In this study, some 15,000 kg of foodgrains were saved (valued at Rs. 45,000) by the investment of Rs. 3500/- worth of Irula labour and transport to kill 2131 rats and mice.

Another way of judging the cost benefit of the Irula approach to rodent control is by looking at the cost of killing each rat — in this case Rs. 1.65. A rat can eat its way through Rs. 1.65 worth of rice in just 25 days, besides the other damage it can cause, so it is obviously worth investing that amount if someone will pay it.

The savings resulting from the capture of 2131 rodents in these trials is estimated at over Rs. 45,000/- and is calculated for a two-month period in an average crop cycle period. These rodents could have, in their 234-acre domain, consumed 50 kg of foodgrain per day, destroyed another 100 kg per day and the lesser bandicoot component (40% of the total rats caught) could cut and store another 100 kg per day. This 250 kg of rice per day (unabated and increasing) throughout a 60-day rice growing period would result in a loss of 15,000 kg of rice. As these rats are locally migratory, aspects such as damage to land through soil loss, damage inside dwellings, death and destruction of eggs and chicks on poultry farms within the study area have not been included in the calculation.

In the literature it is reported that the cost of killing a rat can be as high as Rs. 14 (in a Lakshadweep Islands trial; Whitaker and Bhaskar 1978) or as low as Rs. 0.55 (Thaker 1975). In the latter trials (Thaker) the cost breakdown is not given but the figure of Rs. 30,000 spent to kill 53,767 rats must be for the poison alone. In addition some 55,000 kg of grain were used and a considerable work force of the Sidhpur Municipality and the Rodent Control Project worked for four months. If accurately reported, the expenses incurred would have brought the cost per rat near the Rs. 2/- mark. In the same trial, Project staff only *verified* 13,000 rats dead, the other 40,000 were *reported* dead by the town inhabitants, which leaves considerable doubt as to the accuracy of the figures. The same ambiguity is evident in many rodent control field trials reported on for India.

Prakash (1975) outlines a national rodent control plan to cover 170 million hectares (half the total area of India) and 600,000 villages. He estimates that over 1,300 tons of pesticide will be needed per year for five years. Rao (1975) estimates that a nationwide five-year project would cost over 300 crores of rupees (3 billion). His breakdown follows but neglects to include labour and transport costs:

A.	500 houses (one village)	
	Bait (95 kg grain at 1.50)	Rs. 142.50
	Poison (Rodafarin 5 kg)	Rs. 75.00
		Rs. 217.50
B.	500 acres land	
	Bait (760 kg at 1.50)	Rs. 1140.00
	Poison (40 kg Rodafarin)	Rs. 600.00
		Rs. 1740.00

While the Irula method would seem to be less cost effective when compared with the above figures (Rs. 15/- per acre for control by Irulas compared to Rs. 3.50 per acre in the above), the full costs of the pesticide programme are not given and the Irula approach has a much higher reliability rating.

It can be inferred from the results (Table 3) that two rodent species, namely the lesser mole rat and the soft-furred rat (*Rattus meltada*) are the two most important rodent pests in the study area, accounting for 73% of the total rodents caught.

In addition to the rodents caught, other hole dwelling animals were incidentally caught, including a mongoose (killed by accident while digging) and 24 snakes (which were released elsewhere):

Rat snake	(*Ptyas mucosus*)	6
Cobra	(*Naja naja*)	3
Krait	(*Bungarus caeruleus*)	1
Vine snake	(*Ahaetulla nasutus*)	4
Sand boa	(*Eryx conicus*, *E. johnii*)	10

In addition to the farmer being benefited and the Irulas getting a daily wage, the Irulas sell all the larger rats caught to the Madras Crocodile Bank for croc feed. Large bandicoots (*Bandicota indica*) are sold for Rs. 1.50 each and lesser bandicoots for Rs. 1/- each. In this study the total additional income for the Irulas was over Rs. 800/-. Gerbils were kept by the Irulas for the pot.

At present other economic uses for the rats

TABLE 3

NUMBER OF RODENTS CAUGHT: SPECIES, SEX AND SIZE CLASS

Name	Male	Female	Juvenile	Infant	Total
Bandicota indica	47	81	–	13	141
Bandicota bengalensis	326	359	37	161	883
Tatera indica	43	24	10	8	85
Rattus meltada	81	126	193	252	652
Rattus spp.*	41	34	20	15	110
Mus spp.**	39	75	21	94	229
Total	577	699	281	543	2100

* Two or more species involved.

**Two (*M. musculus* and *M. booduga*) or more species involved.

are being examined, including rat protein for poultry feed, and rat skins and fur in the leather and leather goods trade.

D. *Conclusion*

Fall (1977) describes the history (and failure) of rodent catching for payment:

"The idea of making cash payments or rewards for the carcasses of pest animals has been applied numerous times over the last several hundred years in many countries of the world. The results have usually been the same: the pest problems continue virtually unabated, while a small number of people (usually not those troubled by the pest) learn that they can make a reasonable living collecting bounties. In theory, rat damage could, perhaps be greatly reduced by this method if payments were high enough to capture animals during periods of relative scarcity or to concentrate their efforts on capturing only animals damaging crops. Usually this does not happen".

Fall emphasises that to be effective in controlling crop damage, rodent capture has to be carried out when the crop plants are maturing and are most susceptible to damage. Fig. 1 shows that the Irulas catch a much greater number of rats during the harvest months per field trial than at any other time of year.

The Irulas' methods are uniquely suited to smoke out, dig out and catch rats during crop ripening periods with minimal damage to crops. The economic aspect remains the major consideration. On the basis of the results reported herein, Irulas can make a satisfactory wage on the basis of Rs. 1.65 per rat or Rs. 15 per acre of farmland; this compares favourably with expenditure on chemical control schemes.

The advantages of the Irula approach are considerable when compared with standard chemical control schemes. The most obvious advantage is avoiding continual and increasing use of poisons. There is a positive value in being able to see all the rats being caught and killed. The rats can be used safely for protein, both for humans and livestock (for crocodile and poultry farms). The scheme is labour intensive and provides jobs to people in India's lowest economic bracket.

It is concluded, therefore, that the Irula programme for rodent control is a cost effective, efficient and appropriate methodology for farmlands in India. Its effectiveness for godowns, sheds and dwellings also appears adequate but this aspect will be studied and confirmed in the ongoing field trials supported by Oxfam and the Irula Cooperative. This programme has a nationwide applicability as there are rat-catching tribals in many parts of the country.

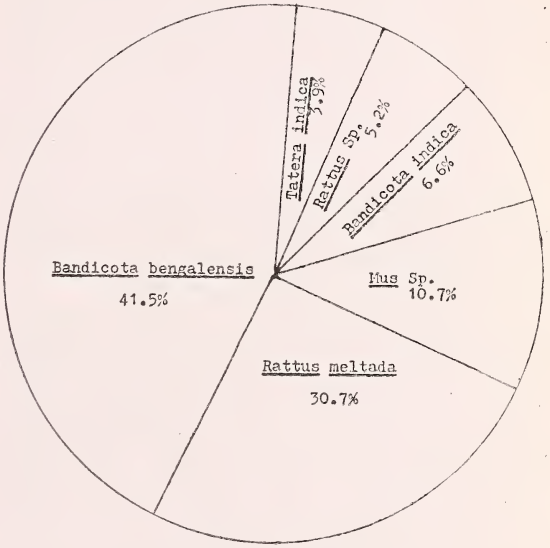


Fig. 2. Species composition.

E. *Recommendations*

It is recommended that the Irula rodent control programme under the title *RATS* be incorporated in the Save Grain Campaign of the Government of India and in the numerous State and Central sponsored programmes of agricultural extension and crop protection concerned specifically with rodent control. It is also recommended that the use of hand caught rats for poultry feed be examined and that a promotional input into the rat fur and leather industry be made by the appropriate Government agencies who have already carried out preliminary research in this direction. One certain way to lessen dependence on pesticides and achieve more complete pest control is to create economic motives for capture of rodents. It is almost axiomatic that any form of wildlife man covets for skin, meat or whatever become endangered species.

It is recommended that the use of capital intensive, environmentally inappropriate chemical control programmes be phased out in favour of the labour intensive soft technology proposed by the Irulas. While it is recognised that the chemical route of control may sometimes be apparently more effective or "appropriate", the long term view of the rodent problem assures us that (a) it will always be with us, and (b) there are hundreds of thousands of tribal and other people in India who are jobless, under-nourished, yet who are skilled and available for a continuous, national rodent control scheme.

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We wish to thank Oxfam (India) Trust for financial support of this project. Thanks are due to S. Dravidamani for initially managing the project. The Irula rat catchers deserve a lot of credit for their skills and their optimism. We also thank D. V. Shyamala for typing, Shekar Dattatri for help with the tables and Zai Whitaker for editing the paper.

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THE BUTTERFLIES OF SIKKIM[1]

MEENA HARIBAL[2], N. D. MULLA[3] AND N. C. CHATURVEDI[4]

Sikkim, a small state to the north of West Bengal, lies between 27° 5′ and 28° 10′ N and 87° 59′ and 88° 56′ E and comprises an area of 750 sq. km. Due to altitudinal variations and climatic conditions the area has an abundant variety of flora and fauna. This region has been explored by Salim Ali (1952-53), Hooker (1856) and De Niceville (1880-83) and during the late 19th and early 20th centuries. There are hardly any reports on the natural history of Sikkim in recent years. Many changes have taken place due to increased human population, deforestation, and other human activities. Hence we undertook the study of the present status of its flora and fauna.

The study was carried out in West and North Sikkim. The following areas were visited: In W. Sikkim we trekked from Geyzing to Dzongri via Yoksum and returned to Legship via Tashiding. The route followed was Geyzing (1500 m) — Pamayangtse (1800 m) — Pelling (1800 m) — Yoksum (2200 m) — Bakkhim (2800 m) — Dzongri (4000 m) — Kaburlake (4500 m) — Yoksum (2200 m) — Tashiding (1800 m) — Legship (1200 m). In N. Sikkim, keeping Singhik as base camp, the surrounding regions were visited and explored: Singhik (1200 m), Mangan (1200 m), Ryngym (1370 m), Sankalang (900 m), Pashingdang (950 m), Tholung bridge (950 m), Manul (1200 m), Nanga Bridge (1220 m) and Ryngbum Bridge (950 m). Gangtok (1800 m), the capital of Sikkim was also visited. Observations, whenever possible, were also made while travelling. A total distance of about 170 km was trekked in about 25 days.

GENERAL OBSERVATIONS

In W. Sikkim, the variation of flora could be observed as we reached higher altitudes. The region around Geyzing, Pelling, Yoksum, Tashiding and Legship was largely under cultivation except for a few pockets of forests. Mostly paddy and buckwheat were being cultivated. Secondary growth was quite abundant in this region which mainly consisted of nettles, *Polygonum*, *Eupatorium Impatiens*, *Gynura*, *Ageratum*, ferns etc. Wild Chestnuts ('Kotus'), *Alnus*, *Ficus* spp., Himalayan cherry, *Mahonia acanthifolia* and bamboos were common in the forested areas. Yoksum to Bakkhim route was through dense evergreen and semi-evergreen forests. *Magnolia* spp., *Michelia* spp., rhododendrons, oak, maple and bamboos were the predominant plants. Nettles, ferns, *Arisema* spp., *Begonia* spp. and *Impatiens* formed secondary growth. Beyond 3500 m rhododendrons, junipers and azaleas were seen.

In N. Sikkim, due to human settlement, the forests were thin but secondary growth was abundant. *Alnus*, Wild Chestnut, fig, *Eugenia*, *Macaranga* and *Erythrina* were most predominant in this region. Secondary growth consisted of *Polygonum*, *Clerodendron*, *Artemesia*, *Piper*, *Ageratum*, *Fagopyrum*, ferns, bamboos and wild bananas. There were a few patches of cardamom plantations.

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The present paper is the result of three short visits to Sikkim by us (MH and NDM). The area was visited in November, 1980 by Meena Haribal, Ulhas Rane, M. R. Almeida, Manek Mistry, Usha Ganguli and Arati Kaikini and by N. D. Mulla and others in November, 1981 and May, 1982.

Observations were made during daytime and mostly up to 15 m distance. Identification was carried out with the help of three standard books (Wynter-Blyth 1951, Talbot 1934 Vols. I & II, Evans 1932) and also by comparing the specimens collected with the specimens in the BNHS collection. About 80 specimens, belonging to 50 species, were collected during the study and are deposited with BNHS.

A larger number of butterflies were seen in November than in May at elevations between 400 m and 2200 m. Tashiding-Legship and Singhik regions were abundant in butterflies (both species-wise and in the number of individuals seen). N. Sikkim has a larger number of butterflies than W. Sikkim.

Some species like the Great Mormons were not encountered in May, even though they were common in November, but the Tawny Costers were seen locally in large numbers only in May. Red Lacewings and Tabby's were very common in Singhik region during November, 1980 but were not sighted by NDM even once in November, 1981. None of the butterflies of the family Amathusidae were seen and only a few species of Papilionidae though quite a few beautiful species like windmills etc. were not seen although they are supposed to be very common during May (Talbot 1947).

Key to notations used in the text for status

VC — very common (20-30 specimens seen)
C — Common (upto 20 specimens seen)
NC — Not common (10 specimens seen)
LC — Locally common (5 specimens seen only at one place)
S — Single or two specimens encountered.

Order: LEPIDOPTERA
Fam. DANAIDAE

1. **Danaus sita sita** (Kollar). Chestnut Tiger; VC.

One of the common butterflies in both W. & N. Sikkim; seen upto 2500 m, mostly in open country near human habitation, often seen feeding on Himalayan Cherry flowers and on moist earth. Seen flying up to 10-30 m above the ground.

2. **Danaus hamata** (Mcleay). Dark Blue Tiger; S.

Two dead specimens were collected — one near a stream at Tashiding and the other entangled on a spider web between Sangkalang and Pashing-dang.

3. **Danaus genutia** (Cramer). Common Tiger; LC.

Seen only at low altitudes near paddy fields in summer at Legship.

4. **Danaus chrysippus** (Linnaeus). Plain tiger; S.

A single butterfly seen flying across the road in Gangtok in November.

5. **Euploea mulciber** (Cramer). Striped Blue Crow; LC.

Seen basking by the roadside at low altitudes in W. Sikkim around Tashiding and Legship.

6. **Euploea klugi** (Housefield & Moore). Blue Crow; S.

Seen feeding on flowers of Compositae at Manul.

7. **Euploea diocletianus** (Fabricius). Magpie Crow, S.

Two butterflies were seen flying above tree level close to each other near Tashiding monastery in a forested patch.

Fam. SATYRIDAE

8. **Mycalesis perseus** (Fabricius). Common Bush Brown; C.

Bush Browns were very common in Mangan, Manul and Sangkalang areas of N. Sikkim. There were also other bush browns, both of dry and wet season forms. Dry season forms were seen in cultivated areas while wet season forms were seen in forested areas of Mangan.

9. **Lethe confusa** Aurivillus. Banded Tree Brown; C.

A common butterfly seen upto 2200 m, abundant at lower elevations; shows strong territorial behaviour; when disturbed flies close to the ground for a short distance. One butterfly observed (MH) had occupied an area of about 10×2 sq.m. along the path with nettles. It had three definite perches, of which two were used more often, sitting with wings closed or half open, when disturbed from a perch, it settled on another and from there back to the first; only twice out of 7-8 times did it settle on a third perch. When another male of the same species approached this patch, it was immediately chased away.

This butterfly can be easily confused with the Straight Banded Tree Browns and Dark Judy but can be distinguished by white patches near the apex.

One was seen feeding from a vessel containing few cooked rice grains.

10. **Lethe insana** (Kollar). Common Forester; S.

One specimen collected from near Sankalang bridge during November.

11. **Lethe sinorix** (Hewitson). Tailed Red Forester; NC.

Seen only in N. Sikkim. Usually near Sangkalang bridge sitting on dry grassy patches on mud banks along the road in cultivated patches.

12. **Lethe verma** (Kollar). Straight Banded Tree Brown; S.

Spotted two specimens — one near Bakkhim, feeding on moist earth, and the other near Pashingdang which was collected.

13. **Lethe siderea** Marshall. Scarce Wood Brown; S.

Only one specimen was observed near a stream between Bakkhim and Yoksum.

14. **Lethe sidonis** (Hewitson). Common Wood Brown; NC.

Encountered only in W. Sikkim between 1800 m - 3050 m, usually on moist earth.

15. **Lethe baladeva** (Moore). Treble Silverstripe.

Two specimens seen — one at Gangtok on a *Eupatorium* leaf, the other near Mangan.

16. **Orinoma damaria** Gray. Tiger Brown; S.

One specimen was caught in Singhik.

17. **Aulocera saraswati** (Kollar). Striated Satyr; S.

A single butterfly seen in the evening near Ryngym monastery above Mangan on moist earth. When disturbed it flew into the valley below.

18. **Ypthima baldus** (Fabricius). Common Fivering; LC.

Locally common in cardamom plantations at Mangan, often seen basking in the sun till late afternoon.

19. **Ypthima sakra** Moore. Himalayan Fivering; VC.

One of the most common butterflies, seen up to 2500 m; very restless, shows strong territorial behaviour, chases away members of its own species, often seen basking in the early mornings. Feeds on nectar of *Anaphalis* sp.

20. **Melanitis leda ismene** (Cramer). Common Evening Brown; LC.

Locally common in thick wooded areas of Gangtok. One specimen was seen at Singtam. It was very common in the orchid sanctuary at Gangtok.

21. **Melanitis zitenius** (Herbst). Great Evening Brown; LC.

Two specimens were seen (wet season form) at the orchid sanctuary on dry leaves.

22. **Elymnias malelas** (Hewitson) Spotted Palmfly; S.

A pair was seen near Tashiding monastery, chasing each other. They often settled on a banana leaf which is the food plant for the larvae of these butterflies; they may have been a courting pair.

23. **Elymnias nesaea** (Linnaeus). Tiger Palmfly; S.

One specimen was caught in the jeep radiator while it was crossing the road during the drive from Rangpo to Singtam.

Fam. NYMPHALIDAE

24. **Eriboea athamas** (Drury). Common Nawab; S.

A single specimen was seen at Rangpo, feeding on flowers.

25. **Eriboea arja** (Felder). Pallid Nawab; NC.

One seen near Sangkalang bridge feeding on moist earth, and another at Ryngbum bridge on the banks of the Teesta. Also one near Gangtok.

26. **Apatura parisatis** Westwood. Black Prince; LC.

Locally common near Manul power station. Ryngbum bridge & Sangkalang. One of our team members licked his fingers after eating a piece of cake and this butterfly settled on the finger to feed on the saliva. This butterfly seemed to be very bold.

27. **Sephisa chandra** (Moore). Eastern Courtier; S.

Two males were caught in Sangkalang area.

28. **Hestina nama** (Doubleday). Circe; NC.

Caught three specimens from Manul and Singhik region. NDM & party found it to be very common in both W. & N. Sikkim.

29. **Stibochiona nicea** (Grey). Popinjay; VC.

Noted as one of the commonest butterflies in cardamom plantations at Mangan and Pashingdang, this was not seen in W. Sikkim by MMH, but NDM saw several at Legship in November. They are very wary when approached, flying as far as 20 to 30 m. They fly close to the ground (3-5 m), seen basking in the mornings on cardamom leaves, with wings partially or fully open.

30. **Euthalia julii** (Bougainville). Common Earl; VC.

One of the common butterflies in cardamom plantations of N. Sikkim, particularly Mangan and Pashingdang areas, in November. Only males were seen by MMH. NDM saw both sexes at Legship and Gangtok. They often sit with wings fully or partially open and show strong territorial behaviour.

31. **Euthalia garuda** (Moore). Common Baron; LC.

Only one male was seen near Pashingdang by MMH. Common in Singtam, feeding on fruits in the bazar (NDM).

32. **Limenitis procris** (Cramer). Commander; LC.

Locally common in Mangan and Manul

areas, often seen basking in the sun; they are very wary on closer approach and feed on marigold and Poincettia flowers.

33. **Pantoporia selenophora** (Kollar). Staff sergeant; LC.

Locally common near Tholung bridge. Eight males were seen on a dry stream bed; all seemed to have freshly emerged.

34. **Pantoporia zeroca** (Moore). Small Staff Sergeant; LC.

Locally common at Tholung Bridge. Four males seen basking in the early morning sun.

35. **Pantoporia opalina** (Kollar). Himalayan Sergeant; NC.

Seen near Tashiding monastery and Mangan up to 2000 m., feeding on flowers of *Mentha* spp. One of the specimens was very badly tattered.

36. **Pantoporia perius** (Linnaeus). Common Sergent; S.

One badly tattered specimen was seen on the road at Mangan.

37. **Neptis mahendra** (Moore). Himalayan Sailer; C.

Common upto 2000 m. in both W. & N. Sikkim, seen feeding on *Anaphalis* spp. & marigold flowers.

38. **Neptis hylas** (Moore). Common Sailer; NC.

Seen at Gangtok, but not as frequently as *N. mahendra*, seen feeding on *Anaphalis* spp. and *Cestrum* spp. flowers.

39. **Neptis soma** (Moore). Sullied Sailer; S.

A single specimen was seen at Gangtok, feeding on *Anaphalis* flowers.

40. **Neptis ananta** (Moore). Yellow Sailer.

A single specimen was seen basking at Manul.

41. **Neptis viraja** (Moore). Yellow Jack Sailer; S.

Two specimens seen in Mangan area.

42. **Neptis hordonia** (Stoll) Common Lascar; S.

A mating pair was observed late in the evening sitting on a creeper by the roadside.

43. **Cyrestis thyodamas** Boisduval. Common map; S.

A single specimen was seen sitting on a bamboo plant near Ryngym monastery above Magan. It often flew down to the ground and went back to the same perch.

44. **Pseudergolis wedah** (Kollar). Tabby; LC.

Locally common between Manul and Nanga bridge along the road, particularly common at Nanga bridge where 10-12 butterflies were seen on the road, sitting with their wings open. Not seen by NDM.

45. **Hypolimans missipus** (Linnaeus). Danaid Eggfly; S.

A single specimen was seen near Tashiding monastery.

46. **Doleschallia bisaltide** (Cramer). Autumn Leaf; S.

One specimen collected while sitting on the mud bank near Sangkalang bridge.

47. **Kallima inachus** (Boisduval). Orange Oak-leaf; S.

Two specimens were seen, one at Sangkalang bridge, the other near Manul.

48. **Precis hierta** (Fabricius). Yellow pansy; NC.

Seen at several places, mostly in open grassy patches near villages and towns.

49. **Precis orithyia** (Linnaeus). Blue Pansy; C.

Common on grassy patches at Gangtok, Tashiding and Ryngym monastery.

50. **Precis almana** (Linnaeus). Peacock Pansy; NC.

Collected a very tattered specimen from Sangkalang. Several others were seen by NDM around Tashiding.

51. **Precis lemonias** (Linnaeus). Lemon Pansy; S.

A single specimen was collected from Tashiding.

52. **Premis iphita** (Cramer). Chocolate Pansy; LC.

Locally common near Ryngbum bridge, seen feeding on Compositae flowers.

53. **Vanessa indica** (Herbst). Indian Red Admiral; C.

Common up to 2200 m. in most of the places. Mostly seen on grassy patches sitting with wings open. This butterfly was once seen being chased by an Indian Tortoise Shell.

54. **Aglais (Vanessa) cashmirensis** (Kollar). Indian Tortoise Shell; VC.

Very common in W. Sikkim, from 950 m. to 3500 m. but less common in N. Sikkim. It has the largest altitudinal range; specimens were seen even in the snow at Dzongri. Seen feeding on *Anaphalis* spp., poincettia and buckwheat flowers. Often sits with wings open shows strong territorial behaviour and is an aggressive butterfly. It once attacked a Common Silverstripe, Common Jester, Red admiral and a bee in about 20-25 minutes, outside Tashiding monastery.

55. **Symbrenthia hippoclus** de Niceville. Common Jester; VC.

Very common up to 2500 m., often basking in the sun. Habits were very similar to those of the sailers.

56. **Symbrenthia hypselis** (Godart). Himalayan Jester; NC.

Two specimens were collected, one from orchid sanctuary late in the evening, the other from Nanga bridge. Several others were photographed by NDM near Yoksum.

57. **Argynnis hyperbius** (Johanssen). Indian Fritillary; C.

Seen in both N. & W. Sikkim up to 2000 m. Males were more common, seen feeding on marigold and *Gynura* flowers and also observed sitting on nettles.

58. **Argynnis childerni** Gray. Large Silverstripe; NC.

Only four specimens were observed in W. Sikkim up to Yoksum (2200 m.). Feeds on *Gynura* and marigold flowers.

59. **Fabriciana kamala** Moore. Eastern Silverstripe; S.

A single specimen was encountered at Geyzing, feeding on *Gynura* flowers.

60. **Issoria lathonia** (Linnaeus). Queen of Spain Fritillary; NC.

Seen only in W. Sikkim up to 3000 m., but not common. Feeds on buckwheat flowers & *Anaphalis* flowers.

61. **Cirrochroa aoris** Doubleday. Large Yeoman; S.

A single dead specimen was collected from Mangan and a wary live specimen was seen at Tashiding.

62. **Cethosia biblis** (Drury). Red Lacewing; C.

One of the common butterflies seen up to 2000 m., but more common between 900 m-

1500 m, seen feeding on *Anaphalis*, polygonum and some Compositae flowers, also on dry human faeces. Usually shy, it does not go very far when disturbed and sits with wings closed.

Fam. Acraeidae

63. **Acraea issoria** (Hubner). Yellow Coster; LC.

Common in N. and W. Sikkim. Both sexes seen feeding on moist earth and *Anaphalis* flowers. A congregation of about 50 butterflies was seen around a bush near Tarku and at Geyzing.

64. **Acraea violaea** (Fabricius). Tawny Coster; LC.

Observed on the way from Tashiding to Legship about 100 specimens were feeding on a flowering plant in May by NDM.

Fam. Erycinidae

65. **Zemeros flegyas** Cramer — Punchinello; VC.

A very common butterfly up to 2500 m., generally sits with wings fully or partially closed on stones or dry leaves, sometimes seen basking in the early mornings. Very slow in flight, it does not fly far when disturbed; quite often sits in the shade.

66. **Dodona durga** (Kollar). Common Punch; LC.

Locally common beyond Yoksum near streams, often basking on rocks with fully opened wings.

67. **Dodona eugenes** (Bates). Tailed Punch; LC.

Locally common between Yoksum and Bakkhim along the streams.

68. **Dodona egeon** (Doubleday). Orange Punch; S.

Two specimens were seen, one at Gangtok near tourist lodge, on *Eupatorium* bush, the other at Mangan.

69. **Dodona ouida** (Moore). Mixed Punch; S.

One male was seen at Gangtok.

70. **Dodona adonira** Hewitson. Striped Punch; S.

One specimen collected from Mangan, another seen by NDM near Bakkhim in May.

71. **Abisara fylla** (Doubleday). Dark Judy; C.

Quite common in W. Sikkim but not seen in N. Sikkim. Occurs between 1400-2200 m usually sitting on the underside of leaves — particularly nettles, with wings partially closed. On an early morning, about 5-6 butterflies were seen at Yoksum basking on the upper surface of *Eupatorium* leaves with wings fully open.

72. **Abisara neophron** (Hewitson). Tailed Judy; S.

One specimen was seen near Manul power station, and another was collected from Nanga bridge, one more specimen was seen in the Orchid Sanctuary, Gangtok.

Fam. Lycaenidae

73. **Poritia hewitsoni** Moore. Common Gem; S.

One dead specimen was collected from Sangkalang bridge.

74. **Celastrina** spp. Hedge Blue; C.

Hedge Blues were fairly common up to 2000 m., but it was rather difficult to distinguish any one specifically. One specimen, collected from Tashiding, was identified as *C. puspa*.

75. **Zizeeria knysna lysimon** Moore. Dark Grass Blue; C.

Seen at several places, feeding on buckwheat, marigold and other Compositae flowers.

76. **Jamides alecto** Fruh. Metallic Cerulean; LC.

Locally common in Sangkalang and Mangan areas but not seen elsewhere; feeding on Compositae flowers and cultivated garden flowers. One butterfly was observed being eaten by a robber fly.

77. **Heliophorus brahma** Moore. Golden Sapphire; S.

Seen only in W. Sikkim around open cultivated areas of Yoksum.

78. **Heliophorus androcles** Moore. Green Sapphire; NC.

Seen above Yoksum up to 2500 m on the way to Bakkhim, in open forest glades, near stream in November and May.

79. **Heliophorus epicles** Fruh. Purple Sapphire; VC.

Seen between 1500-2200 m, feeding on buckwheat, *Cestrum, Anaphilas* spp. and marigold flowers.

80. **Narathura** sp. Oakblue; S.

A single specimen was seen in the early morning at Singhik basking on a grassy patch.

81. **Cheritra freja** (Fabricius). Common Imperial; S.

Only one specimen was seen near Manul power station, basking on the broad leaf of a tree 6 m. above the ground.

82. **Catapoecilma elegans** (Druce). Common Tinsel; S.

A very fast flying butterfly, seen basking on rocks below Tashiding in May.

Fam. PAPILIONIDAE

83. **Princeps memnon** Linnaeus. Great Mormon; C.

Often seen on the route from Tarku to Singtam and from Gangtok to Teesta Bazar, feeding on flowers of poincettia. Six different forms are known to occur in Sikkim (Talbot, 1939).

84. **Princeps polyctor** Boisduval. Common Peacock; C.

Common in wooded country and open areas up to 1500 m. While driving often seen crossing the road. Feeds on nectar of poincettia and marigold. A very fast flier, hardly sits on a flower for more than a second.

85. **Princeps paris** Linnaeus. Paris peacock; S.

Seen only twice. One seen at Sangkalang, and the other collected from Geyzing.

86. **Princeps polytes romulus** Cramer. Common Mormon; S.

A single specimen was seen near Sangkalang bridge on the Teesta river.

87. **Princeps helenus** Linnaeus. Red Helen; C.

Common near Singtam, Mangan, Sanklang and on the way from Gangtok to Singtam in forested areas. Found only at lower altitudes up to 1800 m.

88. **Graphium sarpedon** C. P. Felder. Common Blue bottle.

A single specimen seen at Ryngbum bridge.

89. **Graphium agamemnon** L. Tailed Jay; S.

One seen flying at Sangkalang, and a dead specimen found at Pashingdang.

Fam. PIERIDAE

90. **Delias aglaia** (Linnaeus). Red-base Jezebel; NC.

One specimen seen feeding on Himalayan cherry flowers at Mangan, and a dead specimen collected from Singhik.

91. **Delias acalis** (Godart). Red-Breast Jezebel.

One specimen was photographed at Tashiding by NDM while in flight, and another was seen on Himalayan cherry flowers in November.

92. **Delias descombesi** Boisduval. Red-spot Jezebel; C.

A fairly common Jezebel around human habitations and open areas; seen feeding on Himalayan cherry flowers, and feeding on Lantana flowers. While we watched a butterfly on a lantana bush it was suddenly grabbed by a praying mantis waiting camouflaged in the bush. We could not wait long enough to watch it feed on the butterfly and hence collected both the specimens, but the mantis escaped on the way.

93. **Delias eucharis** (Drury). Common Jezebel; S.

One specimen seen feeding on Himalayan cherry blossoms at Gangtok.

94. **Appias pandione** (Greyer). Spot puffin; LC.

Locally common at Sangkalang, otherwise seen only occasionally. It was seen up to 3000 m with other whites.

95. **Appias indra** (Moore). Plain Puffin

A single specimen was caught at Sangkalang.

96. **Pieris canidia** (Sparrman). Indian Cabbage White; C.

Common, up to 3100 m, seen feeding on *Anaphalis, Polygonum* and other flowers.

97. **Pieris brassicae nepalensis** Doubleday. Large Cabbage White; NC.

Seen up to 3100 m, feeding on buckwheat flowers.

98. **Ixias pyrene** (Linnaeus). Yellow Orange Tip; S.

Two specimens seen flying, one near Singtam, the other at Gangtok.

99. **Hebomoia glaucippe** (Linnaeus). Great Orange Tip; S.

A single butterfly seen flying across the road near Singtam.

100. **Eurema sari sodalis** (Moore). Chocolate Grass Yellow; S.

Seen on the way to Bakkhim from Yoksum, feeding on moist earth. Collected two specimens.

101. **Eurema hecabe** (Linnaeus). The Common Yellow; C.

Seen up to 2200 m, mostly in open areas. Near Sangkalang bridge about 50 butterflies were observed feeding on moist earth.

Fam. HESPERIDAE

102. **Coladenia** spp. Pied flat; S.

A single specimen was seen below Tashiding monastery in a fairly wooded patch.

103. **Caprona ransonnetti** (Felder). The Golden Angle; S.

Two specimens were seen, one at Tashiding, the other at Manul.

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IMMOBILIZATION AND TRANSLOCATION OF NILGAI IN INDIA USING CARFENTANIL[1]

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This paper describes the capture and translocation, over approximately 7 km distance, of 14 nilgai (*Boselaphus tragocamelus*) at Bhatinda, Punjab. A mixture of carfentanil (2-5 mg/animal) and acepromazine (20-50 mg/animal) was used for drug immobilization, mainly conducted at night using a powerful spotlight from a jeep. Carfentanil was reversed using either naloxone (25-66 mg/mg carfentanil) or diprenorphine (10 mg/mg carfentanil). Mean induction time was 4.1 min. and reversal time 6.6 min. The drug mixture used was useful for immobilizing nilgai, primarily due to the short induction time. Standard body measurements of immobilized animals are reported.

INTRODUCTION

A population of approximately 50 nilgai or "bluebull" (*Boselaphus tragocamelus*) were enclosed by a fence in a 450 ha disused ammunition depot at Bhatinda Cantonment, Punjab. The commander of the depot wanted to move the nilgai population to a new depot 7 km from the old site. For this task the Wildlife Institute of India (WII) was asked for technical advice and assistance during April, 1985.

The topography in the enclosure was gently rolling to flat and covered with scattered scrub jungle, with a grass understory. This made it possible to gain access to most of the area by 4 × 4 vehicle.

The capture method selected was chemical immobilization. No published data were available for chemical immobilization of nilgai in the wild. We chose the new experimental drug carfentanil based on reports from African antelope (de Vos 1978) of relatively short mean induction times for impala (*Aepyceros melampus*) of 4.9 min. (n=14), springbok (*Antidorcas marsupialis*) of 4.9 min. (n=5), and Greater Kudu (*Tragelaphus strepsiceros*) of 4.5 min. (n=2). Induction times of less than 5 min. were also reported for cervids such as elk (*Cervus elaphus*) (Meuleman *et al.* 1984), moose (*Alces alces*) (Franzmann *et al.* 1984, Seal *et al.* 1985) and mule deer (*Odocoileus hemionus*) (Jessup *et al.* 1984) in North America.

This paper reports our experiences using a carfentanil/acetylpromazine mixture to immobilize nilgai, approaching animals for darting with spotlights, and use of naloxone and diprenorphine as carfentanil antagonists. We report basic measurements from captured nilgai.

MATERIAL AND METHODS

Carfentanil is a piperadine derivative, with morphine-like qualities but of higher potency. In relation to the widely used immobilizing drug etorphine hydrochloride (M 99, Lemmon Co., Sellersville, PA, USA; Immobilon, Rickett and Colman, Hull, U.K.), about half the dosage of carfentanil is required (Franzmann *et al.* 1984). The common etorphine antagonists, diprenorphine hydrochloride (M50-50, Lemmon Co., Sellersville, PA, USA; Revi-

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von, Rickett and Colman, Hull, U.K.) and naloxone hydrochloride (Naloxone — chemical grade, Sigma Chemical, St. Louis MO, USA; Narcan, Endo Laboratories, Garden City, NY, USA) have been used to reverse the effects of carfentanil. Jessup *et al.* (1984) reported ideal reversal dosages for mule deer as 10 mg diprenorphine or 50 mg naloxone for each mg carfentanil administered. They also reported using acetylpromazine maleate (Acepromazine, Ayerst Laboratories Inc. NY, USA) as an adjunct tranquilliser to potentiate and balance the narcotic effect. We utilized both diprenorphine and naloxone as antagonist drugs and acetylpromazine as an adjunct tranquillizer.

Carfentanil was supplied in 1 ml ampules, containing 10 mg of drug. This concentration was greater than needed and we prepared a mixture containing 1 mg carfentanil and 10 mg acetylpromazine/ml. The drug combination was administered using 2, 3 and 4 ml projectile darts fired from a powder-charged gun (Distinject, Peter Ott Co., Basel, Switzerland) using the appropriate charges based upon projectile size and distance fired.

An open jeep was used to approach the animals and fire the dart. Another jeep and an enclosed 4 × 4 vehicle were used as support vehicles to assist in searching for immobilized animals. This mode of approach worked for the first nilgai, but thereafter the animals became shy and we had to resort to use of handheld spotlights (12 volts; 200,000 to 300,000 candle power) to dazzle and shoot the animals at night, from the vehicle. This worked successfully for several nights but then the nilgai again became wary and difficult to approach. We ceased the operation when spotlighting was no longer successful.

Once an animal was immobilized we checked vital signs (heart rate, respiratory rate, body temperature), checked for injuries, gave an injection of tetracycline hydrochloride (Liquamycin- LA, Pfizer & Co, NY, USA), removed the dart, blindfolded the animal and called in the translocating crew consisting of a detachment of army personnel and a flat bed trunk padded with straw covered by a tarpaulin. The nilgai's feet were tied together and then the animal was loaded onto the truck with the aid of two 8 cm wide 5 m lengths of webbing used as a sling; one at the flank, the other around the chest.

Measurements were made of body length with tail, tail length, body length without tail, shoulder height, chest girth and hind foot length from all animals captured. Horn length and circumference were recorded from male nilgai. Estimates of body weight were made, based on earlier work on nilgai.

The immobilized animals were transported via road directly to the new ammunition depot, 7 km from capture site. A veterinarian accompanied each animal to monitor vital signs and to administer the antagonist upon arrival. At the new site the animal was lowered to the ground, its legs untied, the blindfold removed and the antagonist given on the basis of total mg of carfentanil used for immobilization.

RESULTS

Fourteen nilgai (9 males, 5 females) were translocated to the new site. Only the first animal was captured during daytime, the remainder were captured by the use of spotlights at night, all by darts fired from a jeep. Immobilization dosages/animal (Table 1) ranged from 2 to 5 mg carfentanil (mean=3.2 mg) and 20 to 50 mg acetylpromazine (mean = 32.6 mg). Immobilization dosages/kg body weight (BW) ranged from 0.006 to 0.014 mg/kg. (mean=0.011). Induction times ranged from 3 to 6 min. (mean=4.1) (Table 1).

TABLE 1

DOSAGES AND RESPONSE OF NILGAI (*Boselaphus tragocamelus*) IMMOBILIZED WITH CARFENTANIL/ACETYLPROMAZINE AT BHATINDA, PUNJAB, INDIA (APRIL, 1985)

Animal Number	Sex	Carfentanil mg/ animal	Acepromazine mg/ animal	Carfentanil mg/ kg EW	Induction time (min.)	Antagonist naloxone		mg/animal diprenorphine		Antagonist mg/ mg-carfentanil	Reversal time (min.)	Body temp. (F)	Respiration rate/ min.	Comments
						IM	IV	IM	IV					
1	M	2	20	.006	4.0	110				55	4	100	12	translocated
2	M	2	20+20	.006	3.5		100			50	–	100	20	died (bloat)
3	M	2+1+1	20+10+10	.011	Unk	200				50	15	98	12	translocated
4	F	3	30	.013	3.5		100			33	5	100		translocated
5	F	3	30	.013	6.0	100	100			66	12	101		translocated
6	M	3+1	30+10	.011	5.0		100			25	5	100		translocated
7	M	3	30	.009	5.0		100			33	5	101.8		translocated
8	F	3	30	.013	3.0		100			33	4	99		translocated
9	M	3	30	.009	Unknown		100			33	10	104		translocated
10	F	3	30	.013	3.5		100			33	5	100.4		translocated
11	M	3+2	30+20	.014	4.0		200			48	–	99	8–2	died (resp. failure)
12	M	3+1	30+10	.011	4.0		100			33	5	–		translocated
13	F	3	30+10	.013	3.5			10	20	10	5	99		translocated
14	M	3	30+20	.009	Unknown			10	20	10	5	100		translocated
Mean		3.2	32.6	.011	4.1	Total IV, IM 126		Total IV, IM 30		41 naloxone 10 diprenorphine	6.6	100.2		

a. Based upon estimated weight of 225 kg for females and 350 kg for males.

Only one animal (No. 9) had a rise in body temperature (40°C) that was potentially problematic, but the animal was translocated and did recover. Respiratory rates were recorded for only the first three animals, but were monitored thereafter for only one animal varying significantly from the range of 12 to 20. That animal (No. 11) had a drop in respiratory rate to 2/min. and died soon thereafter. This occurred during translocation and the animal could not be reversed with the antagonist drug in time.

Two mortalities occurred during translocation; one animal died due to bloat and subsequent toxic shock and heart failure, the other due to respiratory failure. The animal that bloated was a large male that, in retrospect, was thought to have been slightly under-dosed (2 mg carfentanil, 40 mg acetylpromazine). He struggled during transport and had to be physically subdued making proper positioning on the sternum difficult to maintain. Moreover, the driver of the truck could not find his way out of the depot and precious time (45 min.) was added to the transport time. This proved too long and the bloat could not be controlled. The animal died a few minutes after arrival at the release site. A subsequent post-mortem examination substantiated the bloat/shock syndrome.

The second translocation mortality was listed as respiratory failure and, in retrospect, the animal was thought to have been overdosed (5 mg carfentanil, 50 mg acetylpromazine). The animal's respiratory rate prior to loading was 8/min. and during transport dropped to 2/min. Reviving the animal during transport was not possible and an attempt was made to get to the new site as soon as possible. On arrival the animal had ceased breathing and a large dose of the antagonist naloxone (200 mg) was given intravenous but the animal did not recover.

During the capture operation, a few animals that we darted were not found because of the heavy cover and/or the animal was lost when the group it was in scattered in different directions. These factors were complicated by the fact that all animals except one were captured at night. The exact number that escaped after being darted was unknown because it was not possible to know for sure if an animal was darted. Nevertheless, we found two animals dead at the captured site, both of which had been darted. One was a young female that we were fairly sure was darted but could not be located. The other was a larger female that had a dart still protruding from the dorsal neck region. Apparently that animal was hit by a dart meant for another animal in the herd. Neither, of course, received the antagonist. Both animals were in a state of putrefaction and determining the cause of death by necropsy was not feasible.

Immobilized nilgai assumed a position of lateral recumbency and tended to kick and struggle vigorously when attempts were made to place them in sternal recumbency. It was nearly impossible for the animals to remain in sternal recumbency unaided.

We captured a majority of males because they were more approachable than females, particularly females with yearlings at their side. Female groups also were larger which often made approaches more difficult as one animal in a group could precipitate flight of all. Males seemed less concerned at approach, and were often found as singles or in pairs. We could have perhaps moved more males, but much time was spent trying to translocate females.

Measurements of nine male nilgai for body length with tail ranged from 225 to 270 cm (mean = 248.6 cm). Tail length ranged from 45 to 73 cm (mean = 51.6 cm); body length without tail ranged from 177 to 236 cm (mean = 200.3 cm); height at shoulder ranged from 130 to 150 cm (mean = 173.8 cm, n = 8); chest girth ranged from 132 to 176 (mean = 157 cm); hind foot ranged from 52 to 57 cm (mean = 55.4 cm, n = 8); horn length ranged from 16 to 23.5 cm (mean = 20.4 cm, n = 8); and horn circumference ranged from 12 to 18 cm (mean = 16 cm, n = 8) (Table 2).

Measurements of five female nilgai for body length with tail ranged from 188 to 236 cm (mean = 219.6 cm); tail length ranged from 44 to 52 cm (mean = 47.8 cm); body length without tail ranged from 143 to 192 cm (mean = 171.8 cm); shoulder height ranged from 100 to 130 cm (mean = 116.8 cm), chest girth ranged from 106 to 132 cm (mean = 126 cm); and hind foot length ranged from 40 to 53 cm (mean = 47.4 cm) (Table 2).

DISCUSSION

The carfentanil/acetylpromazine drug mixture was useful for immobilizing nilgai, primarily due to the short induction times (mean = 4.1 min.). This was particularly important in this operation because capture was primarily done at night, making follow-up of darted individuals more difficult. Another positive attribute of the drug was its reversibility. We were not completely pleased with the level of narcosis because the animals still struggled and kicked while down. We increased carfentanil immobilizing doses and supplemented the dose with additional carfentanil in four instances (Table 1) to attain deeper narcosis. This was successful in only one animal (No. 11), but in this case the dosage was apparently exces-

TABLE 2

MEASUREMENTS (CM) OF NILGAI (*Boselaphus tragocamelus*) CAPTURED AT BHATINDA, PUNJAB, INDIA (APRIL, 1985)

Animal number	Sex	Body length with tail	Tail length	Body length	Shoulder height	Chest girth	Hind foot	Horn length	Horn Circum.
1	M	225	45	180	130	153	52	22	17
2	M	258	52	236	130	146	57	17	16
3	M	270	52	218		162		18.5	17
4	F	188	45	143	118	132	40		
5	F	215	52	163	100	130	53		
6	M	260	73	187	148	160	56	22.5	16.8
7	M	225	48	177	134	154	54.5	23.5	18.0
8	F	229	51	178	130	132	51.0		
9	M	235	45	190	135	164	56		
10	F	236	44	192	122	130	48.6		
11	M	240	45	195	146	166	54	22	17
12	M	257	51	206	134	132	54	16	14.5
13	F	230	47	183	114	106	45		
14	M	267	53	214	150	176	60	22	12
Mean	M	248.6	51.6	200.3	173.8	157.0	55.4	20.4	16
Mean	F	219.6	47.8	171.8	116.8	126.0	47.4		

sive and the animal died. Supplemental acetylpromazine in seven animals (Table 1) did not appear to make the animals more tractable. It was difficult to minimise external disturbances (noise, activity, lights) which may have affected the level of narcosis.

Both antagonists (naloxone, diprenorphine) worked well. Only two animals were given diprenorphine (20 mg IV, 10 mg IM) and both were reversed in 5 min. In each animal, 10 mg diprenorphine was given for each mg carfentanil administered. Naloxone dosages varied from 25 to 66 mg for each mg carfentanil administered. One animal (No. 6) was renarcotized after the initial reversal. This animal was apparently underdosed (25 mg naloxone/mg carfentanil) but with an additional 100 mg naloxone IM the following day, it got up and appeared normal. It was seen for several days thereafter in apparent good health. Six nilgai received 33 mg naloxone/mg carfentanil and were reversed in from 4 to 10 min. Perhaps doses lower than this would be adequate, but with the poor response of the animal receiving 25 mg naloxone/mg carfentanil we were very close to the proper minimum dose when we administered 33 mg naloxone/mg carfentanil IV. Two animals were given naloxone antagonist IM at a rate of 50 and 55 mg/mg carfentanil. Both were successfully reversed in 15 and 4 min., respectively. Another animal received 100 mg each IM and IV of naloxone (66 mg/mg carfentanil) and reversal time was 12 min. (Table 1). The antagonist worked intravenous and intramuscular and in combination, but it was much faster when given intravenous even with a lower dosage rate.

Nightlighting to capture nilgai was successful until the animals became conditioned to flee and/or stay out of range. A possible reason for this was that the spotlight used also illuminated the surroundings, including the vehicle and shooters. An adaptation to possibly correct this would be to mount a tube on the light that would concentrate the beam and prevent spread of light in the adjacent area. The operation was also complicated by the number of vehicles and spotlights deployed at one time. However, it was necessary to have other vehicles in the area to help locate the animals after darting. Better control of their use during the approach may improve capabilities in the future.

We believe that for the most efficient use of resources, we should use vehicle approach and shoot until the animals become wary (probably after two or three nights), and when this occurs discontinue for a period of several weeks. This may not be possible in all cases, to capture the remainder of the animals in the old ammunition depot at Bhatinda it was recommended that this approach be tried.

Measurements (Table 2) were carried out to establish base-line morphometric data for free-ranging nilgai which are lacking. Unfortunately weights and blood data were not obtained but it is recommended that these be obtained on subsequent operations.

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FEEDING AND GROWTH OF HATCHLINGS OF *GAVIALIS GANGETICUS* IN CAPTIVITY[1]

SUSHANT CHOWDHURY[2]

(*With four text-figures*)

Captive feeding and growth of hatchlings and yearlings of *Gavialis gangeticus*, and effect of different seasons on these activities are described and discussed. At a minimum water temperature 22.7°C, feeding diminished considerably but never ceased in sub-tropical Indian climate. Hatchlings and yearlings grew during all the three seasons of monsoon, winter and spring-summer. Growth rate, however, was progressive only in monsoon and spring-summer. In hatchlings food consumption of 9.18% body weight/week is considered roughly as the minimum quantum for registering positive growth. Growth pattern of hatchlings and yearlings are also presented and discussed.

INTRODUCTION

Food intake governs growth of animals. For juvenile and adult crocodilians, food intake is known to be dependent on temperature of the ambient air (Joanen and McNease 1971, McIlhenny 1935, Pooley 1971). If this is equally true for hatchlings and yearling, their growth ought also to be dependent on temperature. Availability of facilities for studying growth of early stages of *G. gangeticus* prompted observations on the effect of temperature on feeding and growth.

MATERIAL AND METHODS

A clutch of eggs collected in April, 1976, from a nest laid on the bank of river Chambal was brought for captive rearing to hatcheries of the Crocodile Rehabilitation and Research Centre, Kukrail, Lucknow. From 60 eggs 51 hatchlings were produced, between June 5 and 12, 1976, as 9 failed to hatch.

The hatchlings were kept in wooden crates having 10-15 cm thick layer of damp sand, containing approximately 10% water by weight. After 48 hours, when the yolk sac was absorbed, 40 hatchlings were randomly divided into four batches of 10, and each batch was released into specially designed ponds (Bustard 1975). Each set comprised 10 ponds, arranged in two rows of five, separated by wire mesh (2 mm gauge) partitions, which material was used for the roof also; each pond measured 2 m square and 33 cm in depth, with one side sloping to zero. One-metre wide space around the hatchling pond was covered with sand, for basking of the young, and at the periphery shady plants (tall fan-palm, *Livistona* sp.) were planted for sheltering the shy creatures and protecting them against the heat. The hatchlings were fed on 2.5-3.0 cm long, live fish of eight species (*Chanda ranga, C. nama, Channa punctatus, Chela laubuca, Labeo bata, Puntius ticto, P. sophore, Rasbora daniconius*) and on the freshwater prawn *Macrobrachium lamarreii.*

At 70-80 cm length, the 40 hatchlings were released into two yearling ponds, of which four in two rows of two comprised a set. Each yearling pool was 4 m square and 1 m deep. The basking area around these extended up to

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1.5 m and the shady plants were more numerous. The yearlings were fed on 7.5-10.00 cm long, live fish of six species (*Channa punctatus, C. marulius, C. striatus, Labeo bata, Catla catla* and *Rasbora daniconius*).

Owing to a time lag of 10-15 days between release of hatchlings into the pond and their settling down to regular feeding, experimentation was started on July 1, 1976, with the recording of the weight of 40 hatchlings at 10 hours. From then onwards each experimental pond was stocked daily between 10-12 hours with a weighed quantity of live fish.

Weekly fish consumption was determined from data recorded at the time of cleaning of the ponds, undertaken every 3-4 days, when uneaten dead and live fish were removed. While the live fish were returned to the cleaned pond, the dead ones were weighed before being discarded. Every week, each hatchling was weighed and its total body length (TBL), from tip of snout to tip of tail, measured. From the weekly record of food consumption of the 40 hatchlings and their biomass, the mean weight of fish consumed per hatchling per week was derived.

Air temperature, relative humidity and rainfall data were obtained from the meteorological station at Amausi (Lucknow), approximately 20 km southwest of the Crocodile Rehabilitation and Research Centre, and the water temperature of the pools at a depth of approximately 30 cm was recorded at 6 hours and 16 hours.

RESULTS

Parallel observations on food consumption and growth were recorded for only one year, from July, 1976 to June, 1977. For the next two years 1977-79, only growth was recorded, the reason being that sufficient quantities of live fish could not always be procured, and occasionally the yearling were fed on chopped pieces of large fish, purchased alive from the local market. Consequently, the amount of food provided could not be recorded accurately. Failure to sex even three-year old gharial of 175 cm mean length thwarted recording of data separately for each sex. In contrast, *Alligator mississippiensis* hatchlings even below six months old could be sexed (Chabreck and Joanen 1979).

Seasonal food intake of hatchlings.

Due to their emergence at the end of summer, the hatchlings immediately encounter the monsoon. During the monsoon, from the third week of June to the last week of September, the mean food consumption per hatchling rose from 44.90 g to 110.60 g, and the mean feeding intensity ranged from 27.61 to 33.24 percent body weight per week (Table 1). In the first winter month of November, a striking decrease over that recorded for October occurred; in the three remaining winter months, December to February, its level remained low (Fig. 1). With the onset of spring in March, food consumption rose, increased during April and May, that for June being slightly lower than for May.

The feeding activity was greatest between 15 and 16 h during monsoon, 12 to 13 h during winter and 17 to 18 h during spring and summer.

Correlation of feeding intensity with temperature (Figs. 1, 2) shows that the hatchlings fed vigorously during the four monsoon and three summer months, when the temperature ranged from 17.46° (in October) to 40.19°C (in June). When, from November to February the feeding intensity was low, the temperature also was low; in March when it was moderate, the temperature had also risen (Fig. 1). From this, 17.46° to 40.19°C, emerges as the optimum range for intensive feeding.

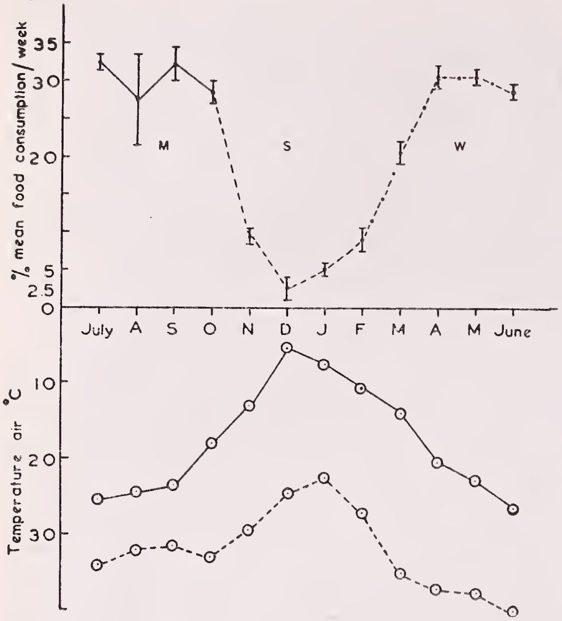

Fig. 1. Temperature-food consumption relationship of hatchlings from July, 1976 to June, 1977. Food consumption (upper half): M, monsoon; W, winter; S, summer. Temperature (lower half): maximum, broken line; minimum, continuous line.

However, the maximum feeding during summer months was recorded in May and not in June (Table 1, Fig. 1). Perhaps greater sluggishness resulting from heat stress, well known in the tropics, reduced their food intake in the hottest and driest month of June, Consequently, the mean May temperature (37.70°C), and not that of June (40.19°C), is regarded as the upper limit of the optimum range, making it 17.46°C to 37.7°C.

The wider range and lower mean of percentage feeding intensity for August than for July and September (Table 1, Fig. 1) is noteworthy. During August, the rainfall is highest and the sky variable, from heavily overcast to patchily cloudy. Consequently, greater and sudden temperature fluctuations are caused and the day temperature is generally lower due

TABLE 1

MEAN WEEKLY FOOD CONSUMPTION AND MEAN MONTHLY GROWTH PER HATCHLING FROM JULY, 1976 TO JUNE, 1977

Seasons	Months and Seasons	Mean weight of fish consumed/ animal/week (g)	Food consumption per cent body weight/week Range	Mean±S.D.	1976-77 hatchling Mean weight g	Mean length cm
	July 1				118.36	36.94
Monsoon, 1976	July	44.90	31.35–34.10	33.24±1.22	136.36	45.68
	August	35.90	21.28–36.12	27.61±6.27	200.56	53.14
	September	84.90	29.40–35.00	32.20±2.35	280.86	56.14
	October	110.60	26.60–30.10	28.50±1.44	393.22	63.14
Winter, 1976–77	November	40.20	8.40–10.50	9.45±0.90	510.80	66.37
	December	14.50	1.60– 3.50	2.55±1.48	457.50 (−53.30)	65.42 (−0.95)
	January	24.70	4.50– 5.86	5.25±0.69	455.23 (−2.27)	65.33 (−0.09)
	February	47.30	7.52–10.60	9.18±1.55	479.98	65.51
Spring, 1977	March	114.40	19.25–21.85	20.77±1.32	516.23	66.78
	April	231.90	29.57–31.96	30.41±1.40	719.86	77.79
Summer, 1977	May	319.65	29.74–30.96	30.40±0.60	1103.15 (1.10 kg)	83.83
	June 30	416.64	27.85–28.29	28.46±0.84	1886.60 (1.89 kg)	96.90

to high humidity. The feeding intensity is thereby believed to be affected more than it is during the less variable months of July and September; hence the wider range and lower mean for August.

Growth rate and feeding of hatchlings.

During the monsoon months, the mean weight and length of the hatchlings increased, the weight increase from 118.36 g to 393.22 g being progressive, the length increase from 36.94 cm to 63.14 cm not being regular (Table 1). In the first winter month (November) also an increase occurred; but in weight and not in length, being even greater than the increase recorded for October. During the two coolest months of December and January the mean weight (457.50 g and 455.23 g respectively) and length (65.42 cm and 65.33 cm respectively) was lower than that in November. But in February, the last winter month, an increase over that in January occurred raising both the weight (479.98 g) and length (65.51 cm). Despite negative growth in December and January, during the winter the mean weight and length increased by 86.76 g and 2.37 cm respectively (Tables 3, 4). Thereafter, during spring (March) and summer (April to June) both the weight and length increased progressively. Over a period of 12 months, the mean weight and length per hatchling increased respectively by 1768.24 g and 59.96 cm (Tables 3, 4); the percent seasonal increase is given in the Tables and shown in fig. 4.

Correlation of growth with feeding intensity (Fig. 2) shows considerable growth of the hatchlings during 7-8 months of vigorous feeding and, despite the low mean feeding intensity, in November also. Of the remaining four months, growth was negative in December and January when feeding intensity was low; it was slight in February, moderate in March when respectively the feeding intensity was slight and moderate.

Growth of yearlings.

During twelve months, the first year yearlings increased in mean weight and length by 4.86 kg and 48.73 cm, and the second year yearlings by 8.60 kg and 29.90 cm respectively (Tables 2, 3, 4). The increase in first year yearlings was progressive during monsoon (July to October) and spring-summer (March to June); in the intervening winter, November to February, the very slight increase in weight was progressive but the slight increase in length was not, because of a mean loss of 0.10 cm in December.

The second year juveniles increased progressively in mean weight during monsoon and spring-summer. In winter, a slight loss occurred in January and February; this is not normal because adequate quantities of fish could not be supplied and they probably metabolized the endogenous food reserve. Their length kept increasing progressively during monsoon and winter; but not during March (spring) as, despite a mean weight gain of 0.10 kg, a mean loss of 1.41 cm occurred. No explanation can be offered at present for this unexpected loss.

Growth rate and ratio of hatchlings and yearlings.

The annual growth rate (Tables 1, 2; Fig. 3) and growth ratio (Tables 3, 4) of hatchlings indicate an approximate increase by 16 times in weight and 2½ times in length; for first-year yearlings these increases are approximately 3½ and 1½ times respectively and for second year juveniles 2¼ and 1¼ times respectively.

Consideration of seasonal growth, as such and as % of annual growth (Tables 3, 4) of the hatchlings and yearlings shows weight gain in successive pre-winter seasons to increase

TABLE 2

MEAN MONTHLY GROWTH PER YEARLING FROM JULY, 1977 TO JUNE, 1979

	Months and seasons	1977-78, 1st year yearling		1978-79, 2nd year yearling	
		Mean weight kg	Mean length cm	Mean weight kg	Mean length cm
	July 1	1.89	96.90	6.74	145.63
	July	2.23	102.88	8.33	145.67
	August	2.53	105.83	9.22	152.40
Monsoon	September	3.14	113.36	9.94	153.10
	October	3.24	114.54	10.08	154.67
	November	3.74	115.82	11.37	155.75
	December	3.75	115.72 (–0.10)	11.48	155.76
Winter	January	3.79	116.42	11.36 (–0.12)	156.40
	February	3.80	116.48	11.20 (–0.16)	159.10
Spring	March	3.93	117.95	11.30	157.69 (–1.41)
	April	4.87	118.52	13.23	160.76
Summer	May	6.10	130.72	13.65	166.69
	June 30	6.74	145.63	15.34	175.53

and that in post-winter seasons to decrease concomitantly (Fig. 4). Length increment shows an opposite trend.

DISCUSSION

The natural diet of *G. gangeticus* hatchlings and yearlings being unknown, they were fed on fish because their elongated snout with marginal teeth is an obvious adaptation for catching fish.

There appears to be no information on seasonal feeding activity and on growth, especially relative to food consumption, for crocodilian hatchlings. Even for adult crocodilians, only the seasonal feeding activity has been studied (Cott 1961, Joanen and McNease 1971), the other area having remained uninvestigated.

Hatchlings of *G. gangeticus* never ceased feeding in the first twelve months; only their food intake diminished greatly during winter months, showing a decrease in natural appetite with low temperature.

In contrast, captive yearlings and adults of *A. mississippiensis* in Louisiana, U.S.A. ceased feeding when water temperature was 60°F (=15.6°C) or less and air temperature 54°F (=12.2°C) or below, with the feeding spell extending for about eight months from mid-October till March (Joanen and McNease 1971). Field observations on juvenile and adult *A. mississippiensis* indicated feeding curtailment during periods of seasonally low temperature (McIlhenny 1935). The crocodile, *C. niloticus,* also refused food when air and water temperatures fell below 60°F (=15.6°C) (Pooley 1971). At the Kukrail rearing centre, the minimum water temperature during winter months being 22.7°C (January), was always considerably higher than 15.6°C, at and below which *A. mississippiensis* and *C. niloticus* ceased feeding. Consequently, non-cessation of feeding by *G. gangeticus* hatchlings during the

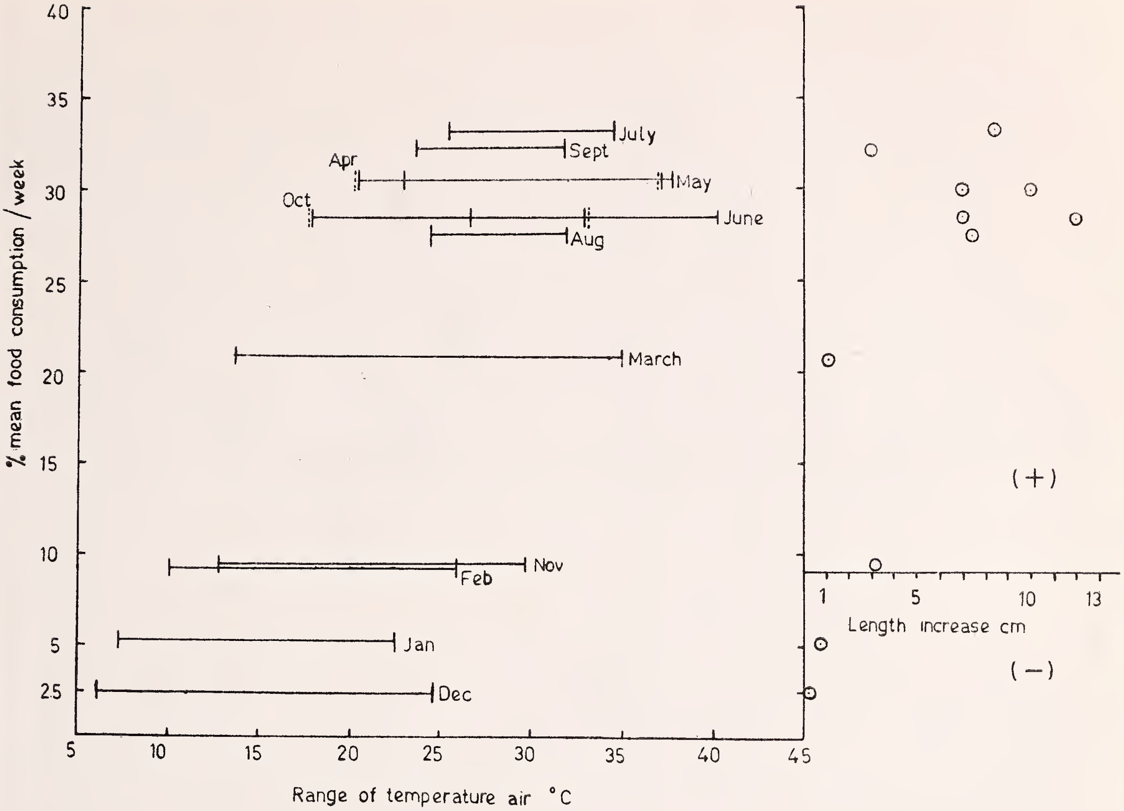

Fig. 2. Temperature-food consumption and length increase relationship of hatchlings from July, 1976 to June, 1977.

entire winter can be attributed to a milder winter in U.P. in subtropical India.

The hatchlings and yearlings grew during all the three seasons, monsoon, winter and spring-summer. Their growth during the eight months of monsoon and spring-summer was progressive and positive; during one or two winter months a slight loss in weight and in length did occur due, obviously, to metabolism of reserve food. However, being slight, the negative growth was offset by the total positive growth that occurred during the clement season. Since in February, the mean food consumption of *G. gangeticus* hatchlings rose to 9.18% body weight per week, and length registered slight increase, this quantity is taken to represent roughly the minimum quantum for fulfilling metabolic needs of the two coldest winter months, when growth is at its lowest.

However, what is not clear is the increase in length and weight of the hatchlings in November, despite low mean food intake of 9.45% body weight per week. A possible explanation is the reduced rate of metabolism, due to the cold, which permitted mobilization of all ingested food into endogenous reserve.

The closest parallel study on growth of newly hatched young is on *A. mississippiensis* hatchlings, produced in the second week of

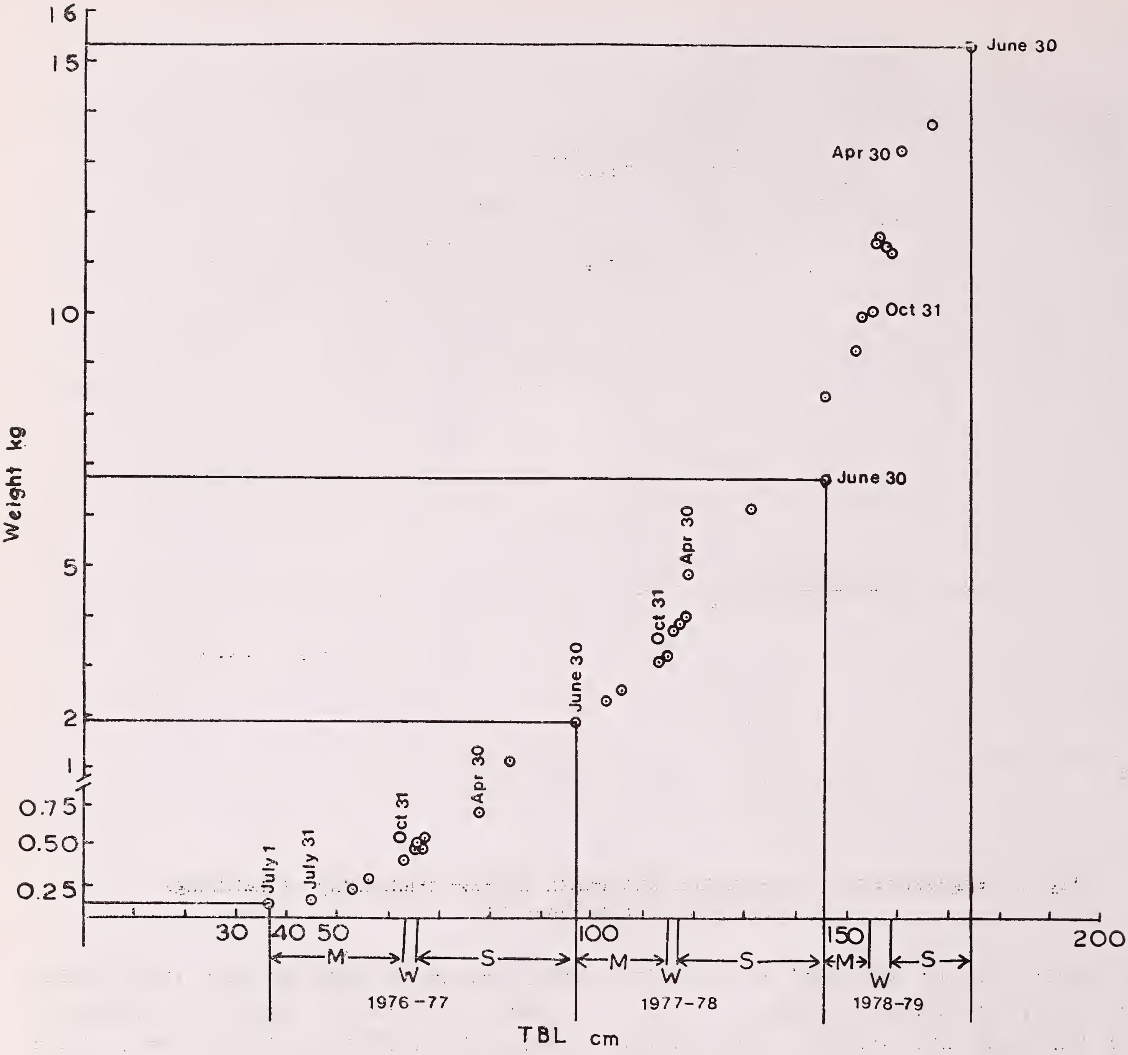

Fig. 3. Weight-length relationship of hatchlings and yearlings from July, 1976 to June, 1979. M, monsoon; W, winter; S, summer; TBL, Total body length.

September (Coulson *et al.* 1973) or in the third week, as determined from data of Goodwin & Marion (1978). According to Figure 2 (Coulson *et al.* 1973), the newly hatched alligator hatchlings were approximately 23 cm in mean length. They grew 69 cm in the first, and 41 cm in the second, twelve months, attaining respectively a mean length of 92 cm and 133 cm (Table 4). In the first six months, September to spring (March) 19 cm and in the next six months, March to September, 50 cm were added to the length of the hatchlings. This unequal growth is due to their arrival in September and passing of earlier life in inclement season, unfavourable for growth.

In contrast to those of the American alligator, the hatchlings of *G. gangeticus* are produced in June, about 2½ to 3 months

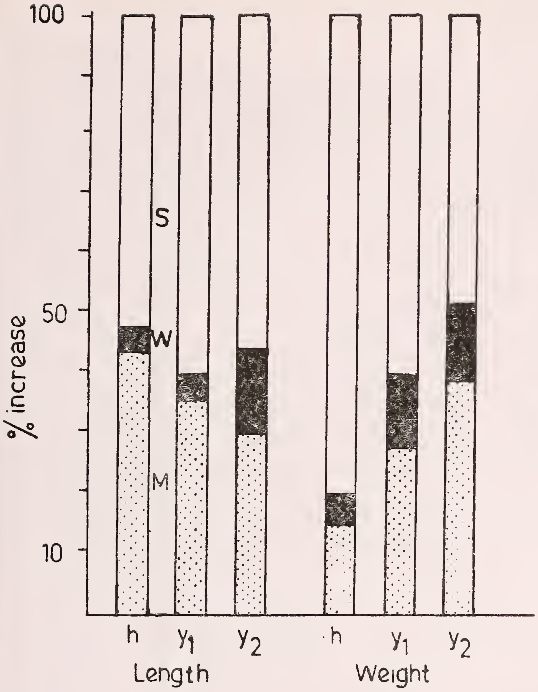

Fig. 4. Seasonal increase in length and weight of young for three consecutive years, from July, 1976 to June, 1979. H, hatchlings; Y_1 and Y_2, first and second year juveniles. M, monsoon; W, winter; S, summer.

earlier and are longer in mean length (36.94 cm). Incidentally, this mean length agrees well with 375 mm given for newly emerged gharial hatchlings (Smith 1931), but March/April, the given months of egg hatching are widely different. In their first twelve months, they increased slightly less (59.96 cm) than hatchlings of *A. mississippiensis,* yet they attained almost the same mean length (96.90 cm) as of the latter (92.00 cm). A break-up of this twelve-month growth shows an almost equal increment before (26.20 cm) and after (31.30 cm) winter. This is due to their arrival well before the winter, so that an equally long and favourable pre-winter period as the

TABLE 3

MEAN SEASONAL INCREASE IN WEIGHT PER HATCHLING AND YEARLING FROM JULY, 1976 TO JUNE, 1979

Seasons and months	Hatchling Weight increase g	Hatchling Percentage	1st year yearling Weight increase kg	1st year yearling Percentage	2nd year juvenile Weight-increase kg	2nd year juvenile Percentage
Weight on July 1	118.36 (1976)		1.89 (1977)		6.74 (1978)	
Monsoon (pre-winter) July to October	274.86	15.54	1.35	27.87	3.34	38.84
Winter November to February	86.76+142.33 − 55.57	4.90	0.56	11.60	1.11+1.40 −0.28	12.95
Spring + Summer (post-winter) March to June	1406.62	79.56	2.94	60.53	4.14	48.21
Increase in 12 months	1768.24	100.00	4.86	100.00	8.60	100.00
Weight on June 30	1886.60 (1977)		6.74 (1978)		15.34 (1979)	
Growth ratio	1:15.4		1:3.52		1:2.27	

TABLE 4

MEAN SEASONAL GROWTH IN LENGTH PER HATCHLING AND YEARLING FROM JULY, 1976 TO JUNE, 1979

Seasons and months	Hatchling		1st year yearling		2nd year juvenile	
	Length increase cm	Percentage	Length increase cm	Percentage	Length increase cm	Percentage
Length on July 1	36.94 (1976)		96.90 (1977)		145.63 (1978)	
Monsoon (pre-winter)						
July to October	26.20	43.69	17.64	36.19	9.04	30.23
Winter						
November to February	2.37+3.41 –1.04	3.95	1.94+2.04 –0.10	3.98	4.43	14.81
Spring + Summer (Post-winter)						
March to June	31.39	52.35	29.15	59.82	16.43+17.84 – 1.41	54.95
Increase in 12 months	59.96	99.99	48.73	99.99	29.90	99.99
Length on June 30	96.90 (1977)		145.63 (1978)		175.53 (1979)	
Growth ratio	1:2.51		1:1.50		1:1.25	
** *A. mississippiensis* young						
Mean hatchling length on September 9	23.00		92.00			
Total length	92.00		133.00			
Growth ratio	1:4.00		1:1.44			

** Data for *A. mississippiensis* taken from Coulson *et al.* (1973)

post-winter period, was available for feeding and growth.

Features of early growth worthy of note are: (1) maximum growth in the first year, (2) much lower weight gain in second relative to first year, and (3) increase in weight gain in pre-winter season and the concomitant decrease in post-winter season.

As in *G. gangeticus*, the two year data of Coulson *et al.* (1973) on *A. mississippiensis* also indicates greater growth in the first year of the alligator's life and the length ratio for the first and second years to be 1:4.0 and 1: 1.44 (Table 4). Comparison of the corresponding ratios (1:2.51 and 1:1.50) of the gharial shows that for the first year to be considerably lower. Yet the hatchlings of both had an almost equal mean length after twelve months (Table 4). This is due to the greater mean length of gharial hatchlings at birth.

Comparison of the other two features was not possible due to lack of corresponding data for other crocodilians.

ACKNOWLEDGEMENTS

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BIOLOGICAL NOTES ON TWO SPECIES OF BIG-EYED BUGS (INSECTA : HEMIPTERA : LYGAEIDAE : GEOCORINAE)[1]

Ananda Mukhopadhyay[2]

(*With seventeen text-figures*)

Some aspects of bioecology like occurrence, mating behaviour, fecundity and post-embryonic development, with nymphal description of two species of *Geocoris, G. pseudolituratus* Mukhopadhyay and Ghosh and *G. bengalensis* Mukhopadhyay and Ghosh are described.

INTRODUCTION

Big-eyed bugs, *Geocoris* spp. are in general omnivorous predators; their predation is often supplemented with feeding on plants (phytophagy) and dead organisms (necrophagy). Such a food habit has endowed these bugs to become natural controlling agents and serve as an important tool for biological control by voraciously appropriating a large number of insect pests. Although such bugs have received much attention in formulating pest management strategies in developed countries, in India the biology and ecology of a large number of these big-eyed bugs are yet to be studied and their role as natural controlling agent of the pests is to be ascertained; this paper presents some bioecological aspects like occurrenee, courtship and mating behaviour, fecundity, and stage of post-embryonic development of the two species, *G. pseudolituratus* and *G. bengalensis* from two different, herbage and litter habitats, respectively.

The members of the genus *Geocoris* Fallén are easily recognized by elliptical profile with nonstalked kidney-shaped big eyes, ventral position of the last three abdominal spiracles and absence of the claval commissure of the wings.

Sweet (1960) established geocorines as predatory. Their phytophagic habit was accounted by York (1964) for supplemental moisture getting, by Stoner (1970) for complete nourishment, and by Dunbar and Bacon (1972) for better reproductive success, and in this act causing only a little harm to plants (Dunbar 1971). Tamaki (1972) studied the biological and ecological aspects of *G. pallens* Stal and *G. bullatus* (Say) while Crocker and Whitcomb (1980) added notes on the feeding niches of the latter and of two more species, *G. punctipes* (Say) and *G. uliginosus* (Say). In India, most of the bioecological reports on geocorines are confined to the commonly available species, namely *G. jucundus* Fieb. and *G. ochropterus* Fieb. by Maxwell-Lefroy (1909), Cherian (1933), Rangarajan *et al.* (1964), Subba Rao *et al.* (1965), and Rawat and Modi (1969). Chatterjee (1937) reported about the habitats and distribution of some Indian geocorines. Mukhopadhyay and Ghosh (1982) have recently added notes on the food-habits and habitats of these two newly described species of *Geocoris, G. pseudolituratus* Mukhopadhyay and Ghosh and *G. bengalensis* Mukhopadhyay and Ghosh from eastern India.

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MATERIAL AND METHODS

(i) *Field collection*:

Collections of the herbage-dwelling *G. pseudolituratus* and its nymphs were chiefly made by using an aspirator and occasionally by beating the herbage. The former method was of some advantage since the chance of escape by the adults was less. The dense litter-dwelling *G. bengalensis* was collected with some difficulty, by fast removal of leaf and fig-fruit litter and quickly sucking in the adults and nymphs by an aspirator as soon as these were seen.

(ii) *Laboratory rearing*:

Both *G. pseudolituratus* and *G. bengalensis* were reared in large vials (10 cm × 3 cm) covered with cotton cloth. To avoid cannibalism, nymphs were reared in separate vials. Fruit flies (*Drosophila* sp.) formed the animal food and herbacious twigs of *Mikenia* sp. supplied the plant food and moisture. Normally over-etherized (killed) fruit flies were provided to the earlier instars (for easy manipulation) and less etherised flies to more advance nymphs and adults. The eggs, laid on the rough surface of cloth or twigs, were separated by a pair of forceps and kept in small vials with moistened cotton plugs for further studies.

OBSERVATIONS AND RESULTS

Overwintering and spring emergence:

Overwintering was not well understood for either of these geocorines. *G. pseudolituratus* and its nymphs were most abundant during spring (February to April) mostly on *Ficus hispida* and associated herbs, showing an apparent spring emergence and population build-up but disappearance of the adult bug was neither observed in the extreme temperatures of the summer nor in winter. During these periods, a dwindling population of the bug thrived in an active state, except at very low temperatures of winter when they stay inactively in leaf folds. *Geocoris bengalensis* was mostly abundant in fig litters during summer and early monsoon. No trace of adults and nymphs of this bug was normally available during the rest of the year. The breeding activity of these bugs in summer depended on the fruiting of the plants, that attracted organisms of the detritus food chain in the litter and these organisms were usually predated by the adults and nymphs of the species. However, only adults of *G. bengalensis* were found in winter or autumn, suggesting that they might be overwintering in adult stage at least in eastern India, the area chosen for study of both the geocorine bugs.

Courtship and mating behaviour:

In general, the two species showed similar mating behaviour, that seldom resulted from a well negotiated process of courtship. The male would generally sense a passing female by straightening its antennae, then orients itself and suddenly jump and grasp the female. Once the attachment was secured, the male slipped down to face in an opposite direction. While mating, the pair normally kept their antennae moving. Mating was repetitive for both the species. While it continued from half to two hours for *G. pseudolituratus*, and about three and a half hours for *G. bengalensis*. Freshly mated females avoided further mating by escaping movements. Successfully mated females of *G. bengalensis* appear to store enough sperm in a single copulation to lay fertile eggs throughout their life.

Oviposition and fecundity:

Oviposition in nature could seldom be observed due to cryptic and scattered habit of egg laying in both the species. However, *G. pseudolituratus* was sometimes observed to attach its solitary eggs to dry part of leaf of the twiner, *Mikania* sp., and some empty egg chorions were collected from the shoot of *F. hispida.* Though it is likely that *G. bengalensis* in nature laid the eggs in litter, yet eggs were difficult to locate in that habitat.

In the laboratory, the egg-laying habit of the two species showed some variation. Surfaces like cottonwool, muslin, hairy surface of twigs of fig fruits, and even bodies of dead flies were preferred by *G. pseudolituratus* for egg laying, whereas axils and branching points of twigs, clefts on surfaces were the first choice of *G. bengalensis,* which also occasionally laid eggs at places like vial surface, or the corner formed by the adjacent surfaces of cotton plug (cover) and vial. Eggs of both the species were attached feebly and superficially, normally scattered or in small clusters of 2 or 3. It was of interest to observe that virgins of *G. pseudolituratus* never laid eggs, whereas those of *G. bengalensis* laid infertile eggs.

Although the average longevity of the two geocorines showed little difference, almost a doubling of the rate of egg laying per female per day was noticed for *G. bengalensis* as compared to *G. pseudolituratus* (Table 1). In general a higher fecundity of *G. bengalensis* was evident in the graphic representation (Fig. 1), when the trends of egg laying were compared from day to day.

Incubation:

The incubation period of the eggs under laboratory conditions was observed in autumn and summer. It was evident that the increase in day temperature shortened the incubation period throughout the course of study. The mechanism of eclosion was the same for both the species. The cephalic ends of the eggs normally ruptured across the circlet and the first instar nymph wriggled out along with the amniotic membrane. This membrane then again ruptured to free the nymph, and itself remained half drawn out from the egg chorion.

The average incubation periods for both the geocorine species were almost the same. However. *G. pseudolituratus* showed a greater range than that of *G. bengalensis* (Table 2). A successful hatching for some batches of eggs could be recorded 100% for both the species, nevertheless, on an average the batches of eggs of *G. pseudolituratus* showed better percentage of hatching when compared to those of *G. bengalensis* (Fig. 2).

TABLE 1

PREOVIPOSITION PERIOD, LONGEVITY AND FECUNDITY OF TWO *Geocoris* SPP. (BASED ON FIVE OBSERVATIONS)

	Preoviposition period (days)	Longevity ♀ (days)	Total eggs laid/♀	Eggs/♀/diem
		G. pseudolituratus		
Mean	11.75	30.75	32.75	1.065
Range	(9–19)	(21–43)	(24–49)	(0.94–1.14)
S.D.	4.856	10.144	11.557	0.0957
		G. bengalensis		
Mean	6.33	32.0	91.0	2.65
Range	(6–7)	(20–46)	(47–166)	(2.0–3.61)
S.D.	0.577	13.144	65.27	0.8467

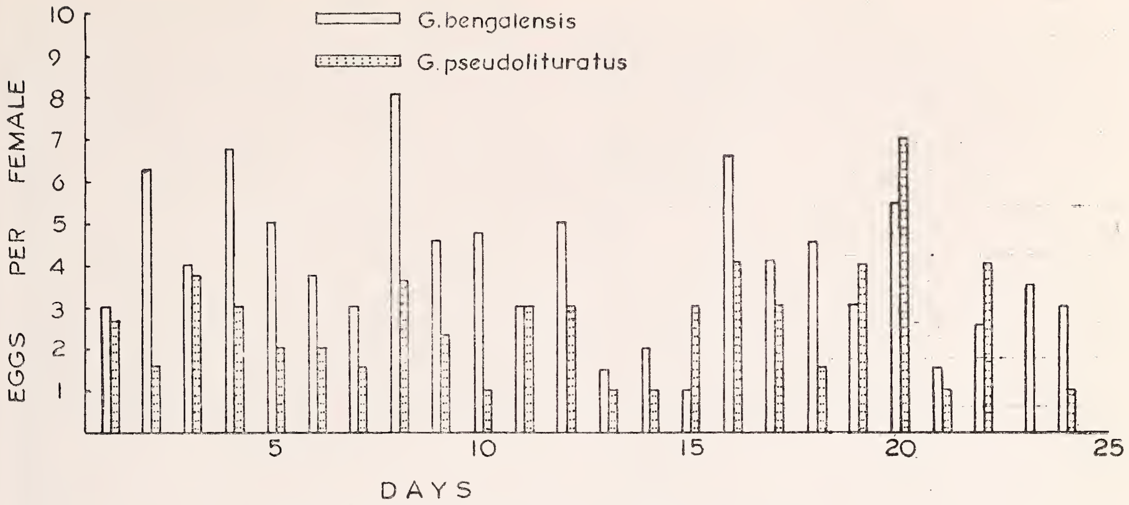
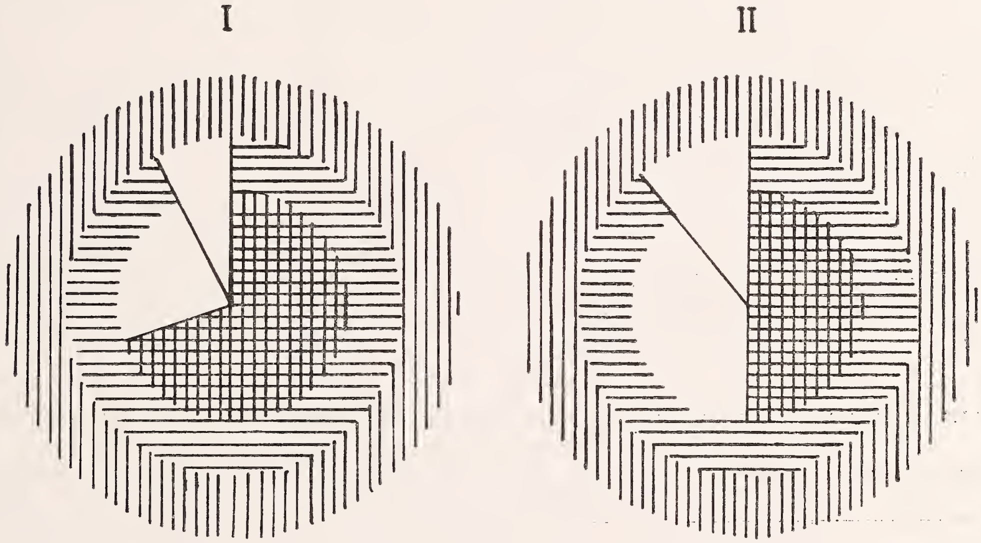


Fig. 1. Oviposition trend of two species of *Geocoris.*



HATCHING SUCCESS	MAX. ▥	AVE. ☰	MIN. ▦
I G. pseudoliturotus	100%	92.5%	70%
II G. bengalensis	100%	89%	50%

Fig. 2. Hatching success in two species of *Geocoris.*

Table 2

Comparison of incubation period and hatching success of the eggs of two *Geocoris* spp. (based on the observation of ten batches of eggs)

	Incubation period (days)	Successful hatching (%)
	G. pseudolituratus	
Mean	9.5	92.5
Range	(7–12)	(70–100)
S.D.	1.527	12.304
	G. bengalensis	
Mean	9.2	89.0
Range	(9–10)	(50–100)
S.D.	0.349	17.126

Post-embryonic development:

The mean post-embryonic development period and the average nymphal stadia were longer for *G. pseudolituratus* than that of *G. bengalensis* (Table 3). However, the stadial ranges for their nymphal stages overlapped (Fig. 3, A-E).

The egg:

Freshly laid eggs of *G. pseudolituratus* were typically ovoid with slightly broad cephalic end, pearly white; on maturation they turned tawny-orange with two eye spots. Under high magnification, the chorionic surface showed tiny warts and a circlet of club-shaped (capitate) micropylar processes (notches) at the blunt head end. A mature egg in late stage showed some wrinkles in the form of narrow ridges and furrows (Fig. 4). The eggs of *G. bengalensis* were also ovoid but elongated and tapered at both the ends; pale with a tint of 'dawn-pink' when fresh but with maturity turning reddish. Chorion under high magnification appeared rough (finely warted), with a circlet of processes at the cephalic end (Fig. 11).

The eggs of *G. pseudolituratus* were shorter, but normally with a greater number of micropylar processes when compared to those of *G. bengalensis* (Table 4).

Description of the nymphal instars:

(Measurements in mm are the means based on ten specimens).

1st nymphal instar (Figs. 5, 12)

G. pseudolituratus: Variable in size and colour; dorsal semi-circular patches appear as two discrete stripes; head width almost 1½

Table 3

Comparison of stadia and post-embryonic developmental period (in days) of two *Geocoris* spp. (based on ten observations)

	1st Instar	2nd Instar	3rd Instar	4th Instar	5th Instar	Total
			G. bengalensis			
Mean	5.9	6.0	6.0	5.3	7.6	30.8
Range	(4–7)	(4–10)	(4–9)	(4–7)	(5–11)	(26–34)
S.D.	0.875	2.054	1.763	0.948	1.577	2.347
			G. pseudolituratus			
Mean	5.7	4.6	4.4	4.6	6.3	25.6
Range	(4–7)	(4–6)	(4–6)	(3–5)	(6–7)	(24–28)
S.D.	0.823	0.843	0.699	0.699	0.483	1.577

Table 4

Comparison of micropylar processes, length and breadth of eggs of two *Geocoris* spp. (Based on ten observations)

	Micropylar processes	Length (mm)	Breadth (mm)
	G. pseudolituratus		
Mean	7.4	0.92	0.37
Range	(7–8)	(0.89–0.94)	(0.34–0.41)
S.D.	0.547	0.089	0.114
	G. bengalensis		
Mean	6.0	1.08	0.4
Range	(5–7)	(1.06–1.1)	(0.38–0.43)
S.D.	0.707	0.07	0.089

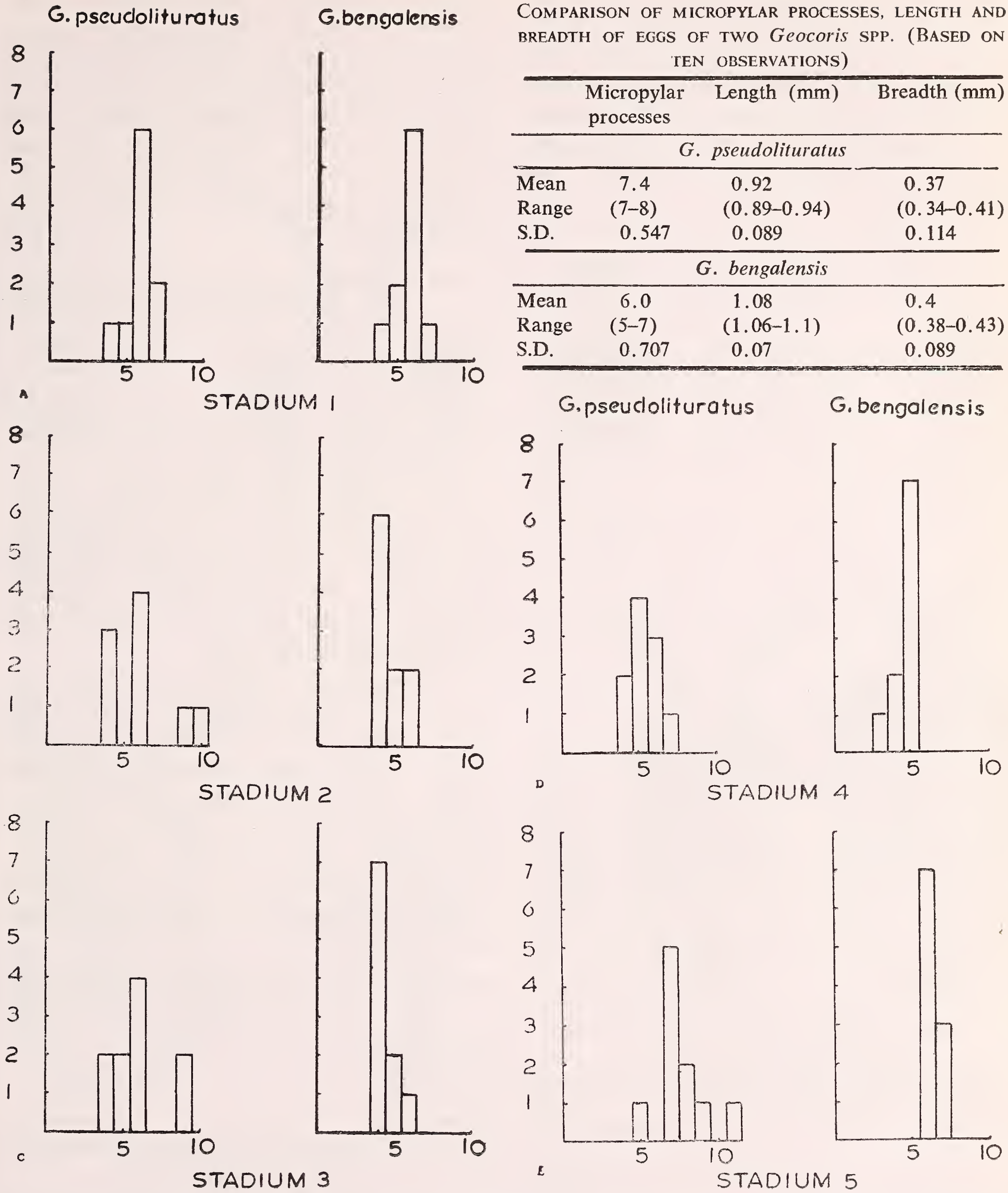
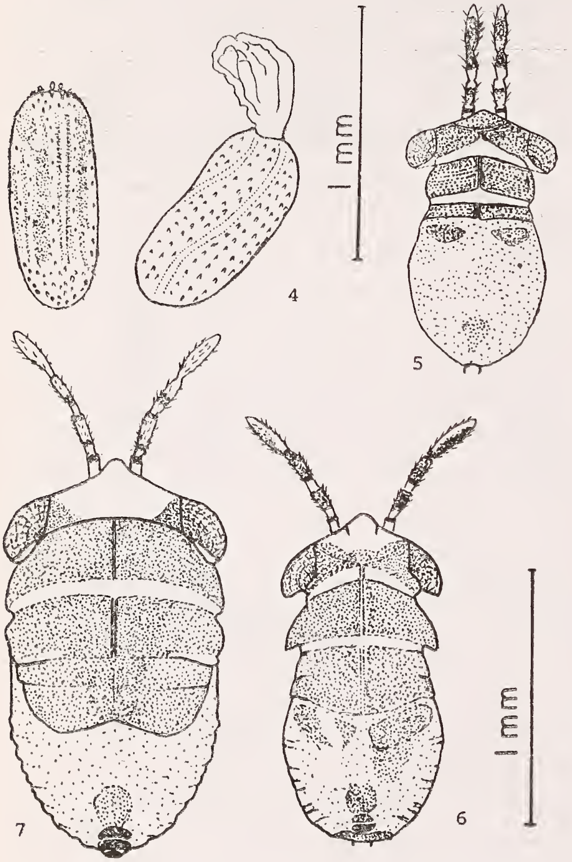


Fig. 3 (A-E). Frequency distribution of duration of instars 1 to 5 of two species of *Geocoris*. Abscissae, time in days; ordinates, number of observations.

times pronotal width; rostrum passes 3rd coxae; head, abdomen pale yellow; posterior margin of head, pro-, meso- and meta-notal area light brown; fuscous rings and markings on distal end of 1st, both ends of 2nd, and proximal end of 3rd antennal segments, 4th segment proximally pale and distally dark smoky.



Figs. 4-7. Stages of life cycle of *Geocoris pseudolituratus* (dorsal view):
4. Eggs showing ridges, micropylar processes, and post-eclosion embryonic membrane; 5. 1st instar nymph; 6. 2nd instar nymph; 7. 3rd instar nymph.

G. bengalensis: Body pale yellow, elongate and cylindrical; head tawny, eyes red; 1st antennal segment luteous, 2nd, 3rd, and 4th with castaneous base and ochraceous apex; vertex region with dark facia; head triangular, broader than pronotum and body; body beneath luteous except dark antennifers; coxae, tibiae, meso- and meta-notum dark; abdomen with tints of red and yellow; dorsal scent gland openings and orifice with castaneous border; ochraceous patch anterior to the 1st dorsal gland opening.

	G. pseudolituratus	*G. bengalensis*
Body length	1.11	1.32
Head width	0.54	0.54
Maximum pronotal width	0.47	0.45

2ND NYMPHAL INSTAR (Figs. 6, 13)

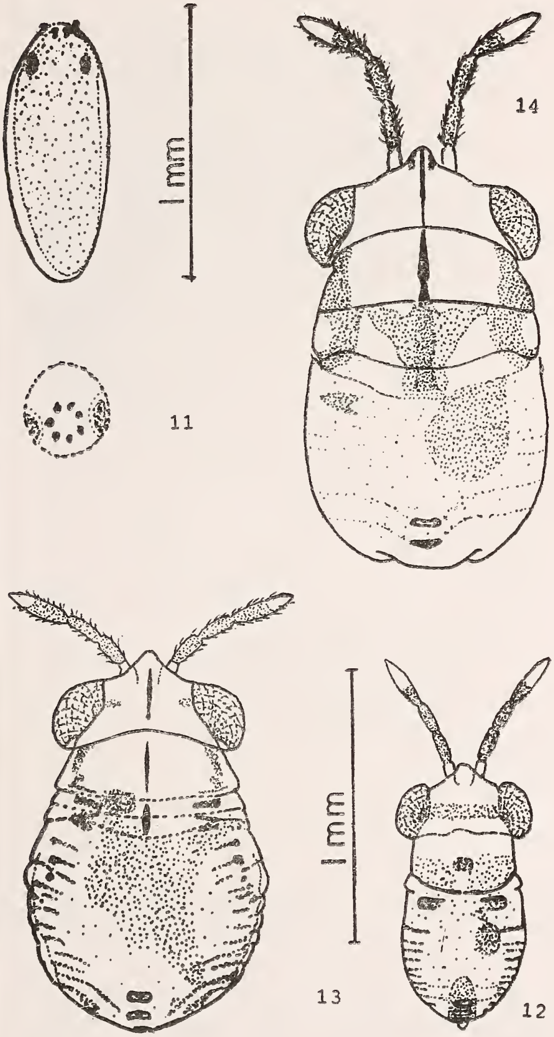
G. pseudolituratus: Head slightly broader than posterior margin of the pronotum; mid-dorsal abdomen with semicircular dark plate divided into two distinct halves; trochanter, proximal femoral area dark ochraceous; 4th antennal segment dirty pale.

G. bengalensis: Ochraceous; head, pro-, meso-, and meta-notum tawny yellow with median dark line that broadens posteriorly, lateral margins dark ochraceous; metanotal region with a pair of dark patches; 4th antennal segment light; abdomen red ochraceous marked with rows of diffused reddish transverse lines; tibia and distal end of femora ochraceous, tarsus dirty white; rostrum reaching 2nd coxae.

	G. pseudolituratus	*G. bengalensis*
Body length	1.45	1.5
Head width	0.75	0.75
Maximum pronotal width	0.66	0.66

3RD NYMPHAL INSTAR (Figs. 7, 14)

G. pseudolituratus: Head and abdomen dirty yellow; pro-, meso- and meta-notum, and mid-dorsal semicircular region dark castaneous; triangles on head at inner corner of eye blackish; incipient wing buds; rostrum reaches 3rd coxae; head just broader than, or equal to, width of posterior pronotal margin.



Figs. 11-14. Stages of life cycle of *Geocoris bengalensis* (dorsal view):
11. Eggs showing micropylar processes; 12. 1st instar nymph; 13. 2nd instar nymph; 14. 3rd instar nymph.

G. bengalensis: Mid-dorsal line of the body red ochraceous, intersected by a short, transverse reddish line at the epicranial region (vertex); postero-lateral edges of the mesonotum form wing-buds; paired stramineous sclerotized abdominal plates; rostrum passes middle coxae; distal subapical end of femora with incomplete brown annulation, concolorous with tibia; sternum luteous except ochraceous anterior margin and coxae; abdomen reddish with a pale line extending throughout the length of body; antennifers castaneous.

	G. pseudoliturratus	*G. bengalensis*
Body length	1.64	1.92
Head width	0.97	0.94
Maximum pronotal width	0.93	0.81

4TH NYMPHAL INSTAR (Figs. 8, 15)

G. pseudoliturratus: Variable in colour, early nymphs red-ochraceous with castaneous pro-, meso- and meta-notum; dorsal abdominal semicircular sclerotized plate turns fuscous in older nymphs of same instar; head stramineous with black triangular patches at margins; abdominal margin red-ochraceous; mesothoracic wing pads cover metanotum; rostrum passes 3rd coxae.

G. bengalensis: Head tawny with dark dorsomedian line; eyes brown; margins and dorsomedial lines of pro-, meso-notum blackish; wing pad blackish, reaching the abdomen; abdomen dirty red, sparsed with yellow patches; two irregular dark spots on abdomen seem to reflect the colour of some internal organ.

	G. pseudoliturratus	*G. bengalensis*
Body length	2.34	2.54
Head width	1.27	1.18
Maximum pronotal width	1.26	1.12

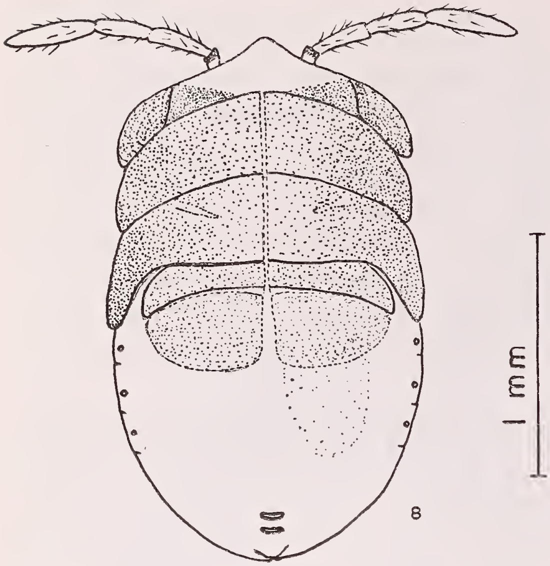


Fig. 8. *Geocoris pseudolituratus*: 4th instar nymph.

5TH NYMPHAL INSTAR (Figs. 9, 16)

G. pseudolituratus: Elliptical, dark-ochraceous; head pale-ochraceous, three times as wide as long; eyes ruby-red; antennae ochraceous, tip and base of the 4th segment pale fuscous, ring at the distal end of first segment; rostrum yellowish with darker 3rd and 4th segments, touches 3rd coxae; pronotum smooth glossy, black-ochraceous, anterior margin semicircular and posterior margin broader than head; wing pads blackish, extending upto 3rd-4th terga; dorsal abdominal semicircular plate dark blackish with abdominal margins dark-ochraceous; orifice (anal) fuscous; abdomen ventrally pale-yellow with a central dark region; pro-, meso- and meta-pleura ochraceous with punctures of same colour; legs yellow-luteous.

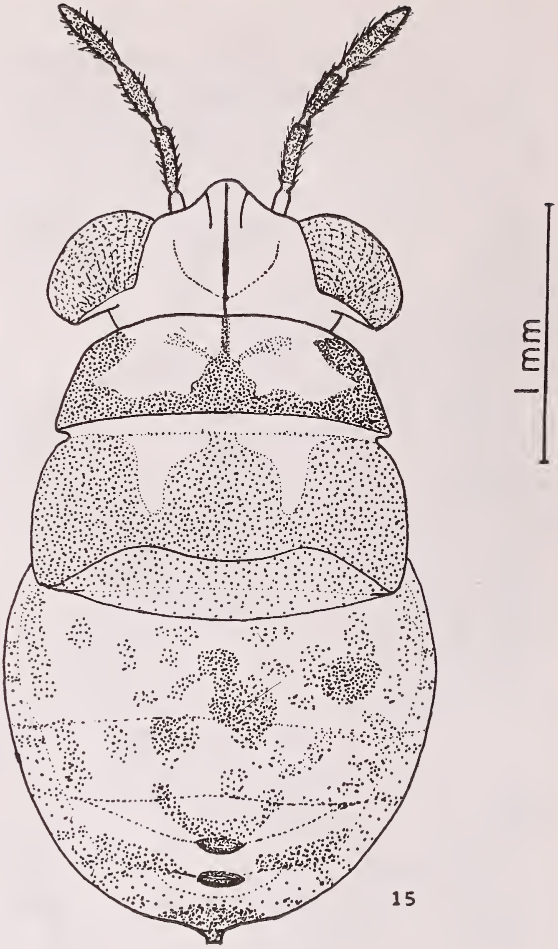


Fig. 15. *Geocoris bengalensis*: 4th instar nymph.

G. bengalensis: Head pale yellow with red patch at vertex region; basal antennal segment with less hair; pronotum black with obscure punctures and dark castaneous lateral margins that continue along the wing pads covering first two terga; black semicircular dorsal abdominal sclerotized plate single; abdomen dirty red with dark openings of dorsal scent glands and orifice (anal); rostrum just crosses 3rd coxae with its 1st and 2nd segments partially dark castaneous; femora pale yellow, each with an incomplete ochraceous annulation at (distal) subapical end; tibiae red-ochraceous, tarsi luteous; 7th abdominal segment with a dark ventral spot.

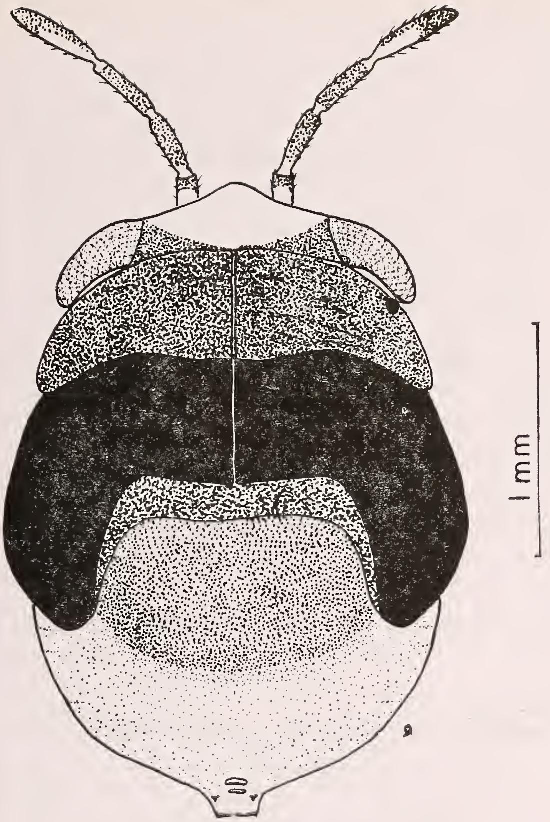


Fig. 9. *Geocoris pseudolituratus*: 5th instar nymph.

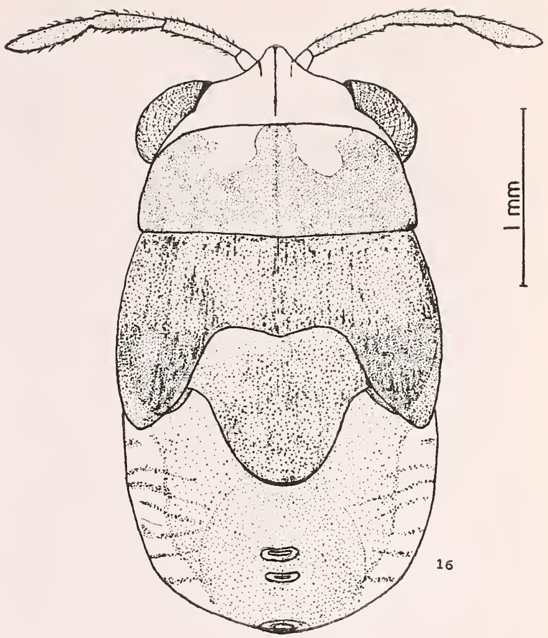


Fig. 16. *Geocoris bengalensis*: 5th instar nymph.

	G. pseudolituratus	*G. bengalensis*
Body length	2.83	3.2
Head width	1.56	1.48
Maximum pronotal width	1.68	1.4

Adults (Figs. 10, 17)

Mukhopadhyay and Ghosh (1982) give a complete description and measurement of adult *G. pseudolituratus* and *G. bengalensis*.

Discussion

Tamaki and Weeks (1972) have shown that the overwintering behaviour of *Geocoris bullatus* and *G. pallens* were contrasting; the former overwintered as eggs and the latter as adults. *Geocoris bengalensis* probably overwinters as adults because in winter no other stages except a few adults were traceable in the litter habitat. The maximum population build-up of this bug was in late spring and just before the onset of heavy rains, synchronized with fruiting of the figs, in particular the banyan. The presence of figs in litter invited innumerable organisms connected with detritus food chain, which also served as the prey species for the mature and immature stages of the bug. The presence of the adults in the late winter and the occurrence of the immature stages of *G. pseudolituratus* in early spring may, in some way, be related to the maximum availability of prey like jassids and their nymphs, aphids, psyllids, and tingid nymphs at that time.

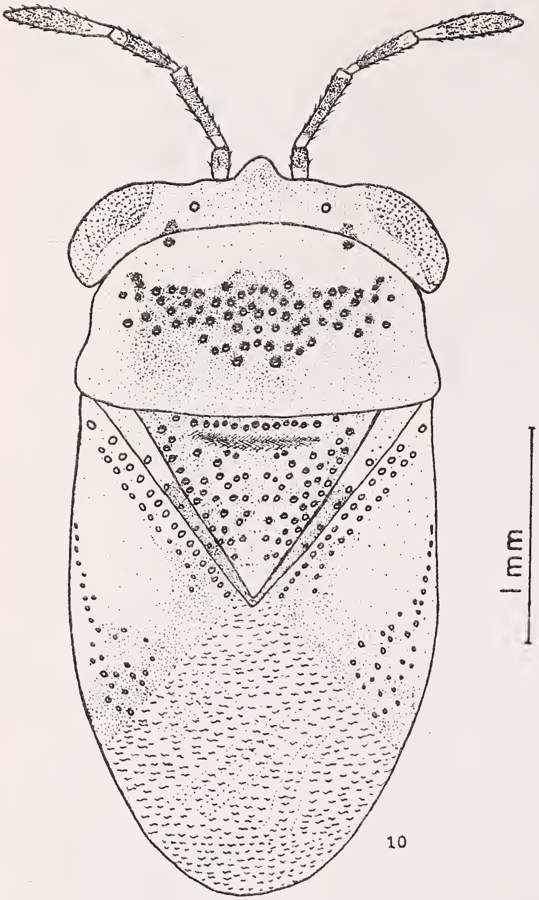


Fig. 10. *Geocoris pseudolituratus*: Adult.

Both the species of the big-eyed bugs showed mating behaviour of the third category (Sweet 1964), where recognition of mates is from a distance with the help of eye and antennae. The antennae of male are normally straightened and pointed at the female before sudden approach or leap for copulation.

Despite minute 'nap' or warts on chorion the shape of the eggs of both the geocorine species showed some adaptive features. 'Cucumber-shaped' *G. pseudolituratus* egg had some obscure longitudinal ribs with anterior end not much flattened, which helped the egg to fit in the surface of a twig or leaf. *Geocoris bengalensis*, a litter dweller, had cylindrical eggs with considerably tapering ends, more suited to fit in the cracks and crevices of a litter habitat. Laying of eggs on the leaves of *Mikania* sp. or fig., in the rolled or indented parts, by *G. pseudolituratus* also appeared to be connected with the exploitation of readily available surrounding prey species immediately after hatching.

Beard (1940) demonstrated that repeated copulations, though normal, were not necessary to maintain fertility in squash bugs, and further showed that fertilized but isolated females produced more eggs and lived longer than normal. However, in the present study it remains doubtful whether copulation instigates egg-laying, since *G. bengalensis* showed an intrinsic rhythm of egg-laying without copulation, while *G. pseudolituratus* failed to lay unless mated. The eggs of an unmated *G. bengalensis* never hatched.

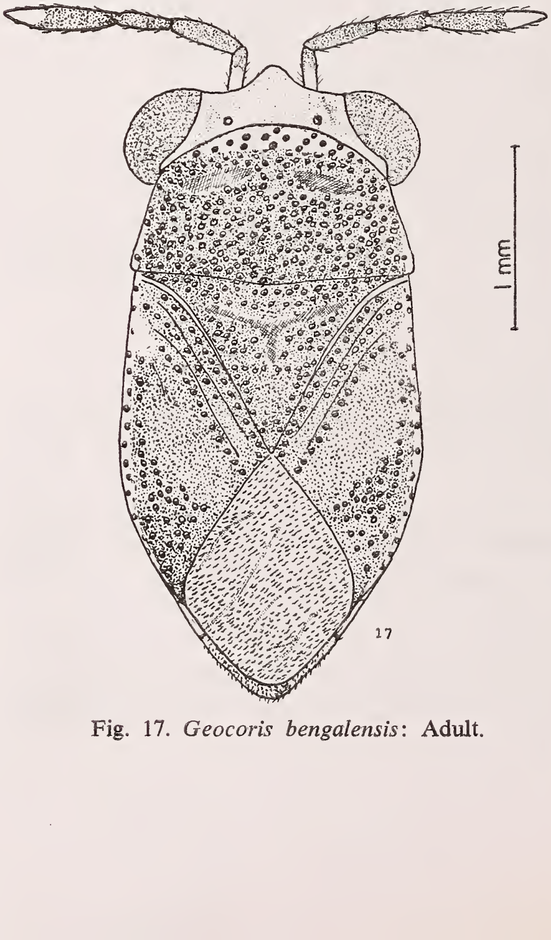


Fig. 17. *Geocoris bengalensis*: Adult.

Tamaki and Weeks (1972) have decisively shown for *G. pallens* and *G. bullatus* that field collected adults laid eggs when they fed either on aphids or sunflower seeds, but a combination of insect, green plant and sunflower seeds resulted in maximum egg-production. It was further noted that a diet of sunflower seeds and green plants gave the maximum longevity, but *Geocoris* fed on aphid-prey and green plants laid more eggs. Similarly it was found for *G. pseudolituratus* and *G. bengalensis,* that an exclusively insect diet did not support life for long. However, as mentioned for *G. pallens* or *G. bullatus,* seeds did not appear to be indispensable in diet, since in nature the *Geocoris* spp. studied by me were never observed to use seeds as an item of their diet. Moreover, egg-laying and longevity were not much affected when the source of moisture, i.e. the green herbacious twig, was replaced by a water siphon. The general tendency of a shorter post-embryonic development period of the litter-dwelling *G. bengalensis* may be necessary for the successful completion of a multivoltine life cycle in the short span of fruiting season of the fig trees when prey is available in the litter. In contrast, a longer development period of the herbage-dwelling *G. pseudolituratus* may be attributed to the availability of various prey species through a greater length of time.

Since *Geocoris* spp. are opportunist predators and are among the most abundant secondary consumer species on crops, their role in keeping the pest load low is reasonably expected; as a corollary, the need for application of the hazardous insecticides is greatly reduced. The initial step that is needed in India is to know bioecology of these 'gem insects', the big-eyed bugs, thoroughly, before appreciating their role as natural enemies in keeping the pest population below threshold value or utilizing these as biological control agents.

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DESTRUCTION OF SPAWNING GROUNDS OF MAHSEER AND OTHER FISH IN GARHWAL HIMALAYAS[1]

P. NAUTIYAL AND M. S. LAL[2]

(*With a text-figure*)

INTRODUCTION

Mahseer is one of the grand game fishes of India. The one-time famous and favourite sport fish of most of the anglers is gradually nearing extinction. Raj (1945) has reported that mahseer has exhibited a gradual decline in Kumaun lakes attributed partly to indiscriminate fishing as well as to cannibalism in the species. According to Kulkarni & Ogale (1978) the use of explosives, killing of brooders, construction of multipurpose dams, 6 hours semiquiescent stage (in *Tor khudree*) and longer hatching period in cold waters are the main causes for the decline of mahseer. Pathani (1977, 1978), and Das & Pathani (1978) while surveying the Kumaun region have reported acute diminution both in size and population, especially in lake Nainital, attributed to increasing pollution, poaching, unscientific fishing of brood fishes and deficiency of oxygen. Recently Singh and Badola (1978) presented a report on seed destruction in Garhwal waters which is also one of the causes of gradual depletion in mahseer population. Whether the same phenomenon is in progress, has yet to be determined. The present contribution is to outline the ecological hazards which the Garhwal mahseer encounters and will ultimately be disastrous.

MAHSEER IN THE HILLSTREAMS OF THE PAURI GARHWAL HIMALAYAS

The Garhwal region comprises of five districts: Pauri, Tehri, Uttarkashi, Chamoli and Dehra Dun. The observations presented here ralate only to Pauri district. River Alaknanda and Nayar are the two main hillstreams of this district, which harbour 43 species in all (Badola 1975). Of the two, the former is snow-fed while the latter is a spring-fed hillstream, and therefore the difference in their ichthyofauna.

Based on observations for the past one year (Jan. 1980 to April 1981) it was found that the population of *Schizothorax* spp. was very high as compared to other coldwater fishes including mahseer. The daily landings comprised primarily of *Schizothorax* species whereas mahseer was landed occasionally. It implies either the use of inefficient fishing implements or lesser number of individuals. Moreover, their number is apt to be less for the adults are temporary visitors (migrants) as they ascend the cold waters of Garhwal Himalayas during the pre-monsoon months. Their upstream migration is undoubtedly for spawning purposes (Singh & Badola 1978) but whether the various water bodies of Garhwal Himalayas can also serve as feeding grounds (Nikolsky 1963) is yet to be determined.

Only two species of mahseer, *Tor tor* and *Tor putitora* have been reported from the Garhwal region. However, the authors with,

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investigating various ecological aspects of Garhwal mahseer have observed that *Tor tor* are far less in number as compared to *Tor putitora.*

Having considered their habits, habitat and economic importance, a systematic analysis of the man-made hazards will give a clear picture of its ecological ignorance.

MAHSEER MIGRATION AND HAZARDS

The phenomenon of upstream migration is peculiar to *Tor* and *Labeo* spp. They ascend from river Ganga in the plains of Hardwar and Rishikesh and reach Deoprayag (Fig. 1) where some migrate into river Bhagirathi; while others continue the upward migration into river Alaknanda. The very first hurdle that it encounters on the onset of migration is the impoundment of hydro-electric project (Chilla project) near Rishikesh. However, as it crosses Rishikesh en route to Deoprayag, it has to survive various traps set in the river. The consolation lies in the fact that man has not yet resorted to extensive dynamiting.

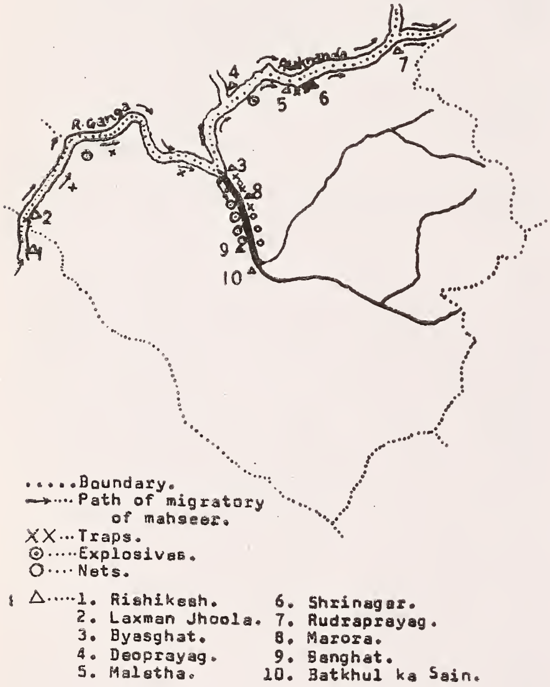

Fig. 1. Migration of Mahseer.

Migration into River Alaknanda: As the population of mahseer ascends the river Alaknanda and reaches Maletha (Fig. 1) it has to be more alert. From there upto Srinagar it faces severe fishing pressure. Some of the individuals also migrate further upstream.

Migration into River Nayar: River Nayar is a product of the Eastern and Western Nayar, the confluence being at a place known as Batkul Ka Sain, which is situated about 3 kilometres before Banghat (Fig. 1). The river stretches for 24 km (approx.) before it merges with Ganga at Byasghat which is about 40 km downstream of Srinagar, between Deoprayag and Byasi. The brood fish are found only when the river is flooded and turbid, during the monsoon months which extends from July to September. It implies that onset of monsoon along with high temperature is responsible for its ascent. Abundance of food does not seem to be an important factor governing migration.

As the brooders ascend they face severe fishing pressure because the river has a slow current as compared to Alaknanda and is easily accessible to man. Hence, various traps are set across the width of the river which prevents escape of the fish. Use of explosives throughout the year consequently leads to destruction of brood fish as well as the seed.

Nature of spawning grounds in Garhwal: The river banks, which, for most of the stretch is primarily of stones, pebbles and sand, at some places consist of almost high perpendicular rocky banks. In the pre-monsoon and monsoon months the rivers swell up with melted snow and rain water respectively, thus submerging the banks which consequently leads to the formation of spawning grounds.

During this period the river is characterized by warm, slightly alkaline and turbid waters along with optimum value of dissolved oxygen. Values of total alkalinity decline due to increasing turbidity and decreasing productivity, a factor which may not have any bearing on the brood fish since it probably does not feed actively during its course of spawning.

The brood fish, as reported by Badola & Singh (1984) lay a very large number of eggs in the shallow waters (35 cm to 50 cm) on or below the stones in the sand which provide an appropriate environment for the eggs to hatch. Pathani (1978) has also stated that mahseer always prefer flowing water and breed in shallow waters with sandy bottoms having a good amount of oxygen.

Besides stone and sand here and there, there exist patches of vegetation on the banks which too may serve as substratum as far as laying of carp eggs is concerned (Nikolsky 1963). The vegetation comprises mainly of hard grasses like *Saccharum* spp. and other shrubs like *Lantana americana, Calotropis procera* etc., which get submerged during monsoon.

Mahseer, however, was not found to breed in the Alaknanda. The latter serves as spawning grounds for *Schizothorax* and other species.

Destruction of spawning grounds

The destruction of spawning grounds is a case of ecological ignorance. When the swollen rivers recede, various contractors and local people carry away truckloads full of stones, pebbles and sand which constitute the during each monsoon the river brings along with it more and more stones, pebbles and sand. Is the source inexhaustible? The main problem is that the stones are loaded from the spots which constitute the spawning grounds. If this process continues it will ruin the whole of the spawning grounds which may lead to extinction of the noble mahseer from this region.

Conclusion

Thoughtless destruction of these spawning grounds is undoubtedly disastrous.

In order to solve these hazards the Government should ban fishing of brooders, use of explosives, icthyotoxic plants and overfishing of juveniles. Further, better implements for fishing should be used to harvest the crop. Artificial or induced breeding must be undertaken to achieve a commercial magnitude so that various rivers and lakes of Garhwal Himalayas can be restocked. Above all detailed ecological and biological study of the mahseer is essential.

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RESPONSE OF WILD GOATS TO HUMAN DISTURBANCE NEAR A WATERPOINT IN KIRTHAR NATIONAL PARK, PAKISTAN[1]

W. DANIEL EDGE[2], SALLY L. OLSON-EDGE[2] AND NASIR GHANI[3]

The response of wild goats (*Capra aegagrus*) at a waterpoint to construction of a well 600 m away was observed from March through May, 1986. The well was constructed between 0900 and 1800 h in April and May. Groups of goats that drank from the waterpoint were 51%, 34% and 71% of all groups that approached the waterpoint during March (n = 35), April (n = 71), and May (n = 48) respectively. The number of goats drinking per month increased from 344 in March to 730 in May. During March, 97% of the goats visited the waterpoint between 0900 and 1800 h. However, during the construction in April and May, only 51% of the visits occurred during this time period; the other 49% visited either earlier or later in the day. Construction activities at such sites should be timed to avoid the pre-monsoon season during which goats are dependent upon the water.

INTRODUCTION

The wild goat, locally known as the Sind Ibex, is the most abundant large mammal in Kirthar National Park, Pakistan, and is the dominant native ungulate in many of the hill ranges throughout Sind and Baluchistan. With the exception of brief studies by Roberts (1967), Schaller and Laurie (1974) and Schaller (1977), little is known about the ecology of the wild goat in Pakistan. During a study of the biology and behaviour of wild goats and urial (*Ovis orientalis*) at a waterpoint in Kirthar National Park, Edge *et al.* (in press) reported that less than half of the wild goat groups ($\bar{x}$ group size 18.8) that approached the waterpoint actually drank. In this paper we report the response of wild goats to construction activities at a nearby well.

STUDY AREA AND METHODS

Kirthar National Park lies approximately 150 km northeast of Karachi, Pakistan, between latitudes 25° and 26°N. The park is bordered on the east by the Surjan, Sumbak and Hothiano Game Reserves and on the west by the border with Baluchistan. The mean maximum and mean minimum temperatures from March through May were 38°C and 27°C respectively. No weather station was maintained in the park, but local residents reported that there was very little rainfall in 1984 and 1985. The 3,087 km² area encompassed our core study area, the Karchat Hills, of which Schaller and Laurie (1974) gave a detailed description. The Janko waterpoint, where our observations were made, was previously described by Edge *et al.* (in press).

A well, 600 m south of the Janko waterpoint, was constructed during April and May, 1986. A crew of four to six men worked on the well between 0900 h and 1800 h four or five days a week during the two months. The well is visible from a ridge overlooking the waterpoint.

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Wild goats were observed with 10x binoculars or a 15-35 x telescope between the hours of dawn and dusk from a blind 66 m from the waterpoint. From March to May, 1986 we captured wild goats with a remotely-fired net-gun aimed at the waterpoint, or with Aldridge leg-hold snares placed around the waterpoint. Captured animals were marked for individual identification with colour-coded and numbered plastic ear-tags.

RESULTS

We watched the Janko waterpoint a total of 416 h, over 32 days, between 21 March and 21 May, 1986. During this period we captured and marked 34 wild goats (26 females and 8 males) — 24 with the net-gun and 10 in snares. One hundred and fifty-three groups of wild goats approached the waterpoint during our observation but only 49% of these groups actually drank. The number of groups that drank from the waterpoint was related to month ($X^2 = 15.3$, df = 2, $P < 0.01$). In March, 51% of the groups drank, compared to 34% in April, and 71% in May. The percentage of groups that drank only during construction hours decreased from 83% in March, when there was no construction, to 59% in May (Table 1). However, the time of visit for groups was not related to month ($X^2 = 3.43$, df = 2, $P > 0.1$).

TABLE 1

NUMBER (AND PERCENTAGE) OF WILD GOAT GROUPS DRINKING FROM THE JANKO WATERPOINT BY MONTH DURING (0900-1800 H), AND BEFORE OR AFTER CONSTRUCTION PERIODS, 1986

Time of visit	Month March[1]	April	May
0900 to 1800 h	15 (83)	17 (71)	20 (59)
Before 0900 h or after 1800 h	3 (17)	7 (29)	14 (41)

[1] No construction occurred during March.

The number of individual wild goats that drank from the waterpoint increased from 344 in March to 730 in May (Table 2). The time of visit for these animals was related to month ($X^2 = 236$, df = 2, $P < 0.01$), with 97% of the visits in March occurring between 0900 and 1800 h. However, during April and May, only 51% of the visits occurred during this time period.

TABLE 2

NUMBER (AND PERCENTAGE) OF INDIVIDUAL WILD GOATS DRINKING FROM THE JANKO WATERPOINT BY MONTH DURING 0900-1800 H AND BEFORE OR AFTER CONSTRUCTION PERIODS, 1986

Time of visit	Month March[1]	April	May
0900 to 1800 h	333 (97)	251 (51)	375 (51)
Before 0900 h or after 1800 h	11 (3)	243 (49)	355 (49)

[1] No construction occurred during March.

DISCUSSION

Wild goats responded to construction of a well, 600 m from the Janko waterpoint, by a shift in drinking periods. With the onset of construction in April, the percentage of groups that drank from the waterpoint decreased. This decrease in drinking success was accompanied by a shift in drinking time; individual goats that drank predominantly between 0900 and 1800 h in March, shifted much of their drinking activity to outside these hours in April. During May, 49% of all individual wild goats that drank did so either before or after construction periods; this was accompanied by a marked increase in the percentage of groups that drank. Jorgensen (1974) and Campbell & Remington (1981) reported that desert bighorn sheep (*Ovis canadensis*) modified their drinking patterns in a similar manner to avoid human disturbance.

One could argue that the partial shift in water-use patterns to early morning and late evening periods, during April and May, may correspond to increasing temperatures. However, local game watchers and wildlife enthusiasts reported that the water-use patterns we observed during March were the normal patterns for April and May. In addition, wild goats that approached the waterpoint during construction periods did so cautiously, constantly looking in the direction of the well.

Kirthar National Park is a remote area and receives very little visitor use. In addition, the park staff is not adequately equipped to prevent poaching in the park. Flight distance of wild goats from people on foot in the park often exceeded 1 km (Edge & Olson-Edge, unpubl. data). Goats within the park responded to human presence in a manner similar to wild populations outside the park and have not become habituated to humans. Wild goats at the Janko waterpoint did not show a complete shift in water-use activity, probably because the disturbance was 600 m away, and because the waterpoint was the only source of water available to them. Had the construction been at or closer to the waterpoint, we believe a complete shift in water-use patterns would have been observed.

Our trapping activities at the waterpoint undoubtedly caused some disturbance. However, the disturbance was minor and could not account for the shift in water-use patterns we observed. We trapped throughout the day and developed a conservative trapping program to reduce the possibility of disturbance. We rarely trapped more than three consecutive days a week, and used the net-gun to capture wild goats only when the group size was less than 20. We relied on snares to capture wild goats when the groups were greater than 20, and we did not approach the captive goat until the entire group drank and walked away. Nevertheless, managers should be aware of the potential disturbance that can be caused by trapping at water sources (Leslie & Douglas 1979).

The results of this study indicate that wild goats will be sensitive to human disturbance at or near water sources. Construction projects and other human activities at or adjacent to water sources should be carefully evaluated for their potential effects on wild goat populations. Construction activities at such sites should be timed to avoid the pre-monsoon season during which wild goats are dependent upon the water.

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IMPACT OF GUANO DEPOSITION IN VEDANTHANGAL WATER-BIRD SANCTUARY (CHENGALPATTU DISTRICT, TAMIL NADU)[1]

S. PAULRAJ[2]

Impact of guano deposition by water-birds at Vedanthangal Water-bird Sanctuary was studied. Chemical composition of water-birds' guano showed that it contained 29 mg/g (dry weight) of NO_2 and NO_3 nitrogen and 89.8 mg/g (dry weight) of P_2O_5. Guano, dissolved in tank water contained 1.73 mg/l of nitrogen and 4.40 mg/l of P_2O_5. Vedanthangal tank-irrigated ayacut soil contained 206 kg of nitrogen; 130 kg of P_2O_5 and 97 kg of K_2O per hectare. Nitrogen and P_2O_5 content of Vedanthangal tank-water and tank-ayacut soil showed a significantly higher level when compared to neighbouring tank-water and tank-ayacut soil. The quantum of benefit received by Vedanthangal ayacut farmers due to guano deposition was assessed. There was also a fertility gradient noticed in Vedanthangal tank-ayacut.

INTRODUCTION

In the years following the first general realisation of the importance of phosphorus in the middle of the 19th century, came the discovery of the guano deposits on some Pacific Islands. These are huge mounds of the droppings of sea birds valuable as fertilizers. The birds ate fish, whose bodies were rich in phosphorus, and much of the phosphorus was voided with the bird's droppings. It was obvious that an enormous tonnage of phosphorus had been returned from the sea to land in this way.

Hutchinson (1950) first studied the annual return of phosphorus from the sea by the sea birds, which was calculated to be 70,000 tonnes for the entire world. Ali (1972) feels, "although no deposits of like magnitude or value exist within our limit, yet the possibilities of the 'liquid guano' of colonial-nesting water birds have not been seriously exploited in India". But the fertilizing effect of this 'liquid guano' was realised by the people of Vedanthangal as early as 1790, much earlier than the realisation of the importance of the guano deposits (Spillett 1966).

It was estimated that more than 25,000 breeding and non-breeding water-birds congregate during the season inside this tank (Paulraj 1984, Annamalai 1985). Daily deposition of large amounts of droppings by these birds in this compact tank area of 30 ha. makes the tank water turbid and the tank water is converted into a 'liquid guano' in due course. When this guano-rich tank water is used for irrigating the fields, it enriches the soil with phosphate and nitrate fertilizers.

There are several references in literature indicating the fertilizer property of the liquid guano (Thangam 1956, Spillett 1966, Santharam 1984). But none of them gives any quantified data regarding the fertilizer status and the level of benefit due to the addition of the guano. The present study was aimed at finding the impact of the liquid guano on the soil and agricultural productivity in and around Vedanthangal water-bird sanctuary tank ayacut.

METHOD

The composition of the essential macro-

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elements, nitrogen, phosphorus and potassium were analysed in guano, tank water, tank silt and in the field soil of Vedanthangal. The pH and electrical conductivity (EC) of the soil and water were also tested.

Only available NPK were estimated; soil and part of water analyses were done in the Agricultural Soil Testing Laboratories at Kancheepuram and Theni and in the Soil Science Laboratory at Coimbatore. The chemical composition of the guano and tank water were done with the help of the Botany Department, University of Madras.

For a comparative study, silt and water of Maduranthangam tank were also analysed. Already available data on the fertilizer status of the Maduranthagam tank ayacut were obtained from soil testing laboratory, Kancheepuram. This was taken as a control as it is located very near Vedanthangal and there is no congregation of birds.

Analysis of soil

Sampling: The soil samples from Vedanthangal tank ayacut area were collected from many places so as to represent the entire area. To know whether there is any fertility gradient, the entire stretch of the field (about 300 metres) from the tank bund to the extreme end of the ayacut was divided into three divisions of 100 metres length each. The first one represents ayacut near the tank, the second represents middle ayacut land, while the third division represents the farthest ayacut from the tank bund. From each division, soil samples were taken from five localities so as to represent the entire area. While taking soil samples the sampling technique prescribed by the Agriculture Department was carefully followed (Devadoss 1981).

Silt from the tank was obtained by scraping the upper layer of the soil in a few places inside the tank.

The analyses were done for (1) the available nitrogen, prosphorus and potassium and (2) EC & pH levels.

Analysis of water

Water samples were taken in various places of the tank at various depths in the evening from Vedanthangal tank and Maduranthagam tank. The Vedanthangal water was very turbid due to the accumulation of guano. This was taken during March, which was the peak period for bird congregation. The Maduranthagam tank water was very clear and there was an abundant growth of branched algae rooted in the bottom soil.

Both the water samples were tested for their suitability for irrigation by the Agricultural Soil Testing Lab. The available nitrogen (NO_2 & NO_3) and phosphorus (P_2O_5) were estimated following the methods mentioned for estimating NO_2, NO_3 and inorganic phosphorus (Trivedi and Goel 1984); pH was determined by a pH meter.

Turbidity of water: The turbidity of water was determined by measuring the light penetration depth by Secchi disc at various parts in the Vedanthangal and Maduranthagam tanks.

Analysis of guano: Guano of various breeding birds were obtained from the vacated nests. They were mixed together and composition of NO_2, NO_3 and $P_2 O_5$ were found out by the methods mentioned earlier.

Statistical analysis: The following statistical analyses were done.

(1) Test of significance by comparison of means,

(2) Analysis of variance (see Lewis 1971).

Observations and Results

Soil analysis: The analytical results of soil analysis of Vedanthangal tank ayacut reveal that the salt level (EC) is 0.36± 0.1 and the pH is 7.36±0.49 in Vedanthangal tank ayacut soil. The mean fertilizer levels of the tank ayacut soil are N = 83.7±31.3, P = 52.7±22.5 and K = 39.14±19.4 kg/acre (n = 36), while the fertilizer levels of nearby Maduranthagam tank ayacut soil are, N = 75.15±17.1; P = 33.05 ±10.7 and K = 103±40.9 kg/acre (n = 40).

The silt of Vedanthangal tank contains 1093 kg of nitrogen, 106 kg of phosphorus and 185 kg of potassium per hectare. The pH ranges from 6 to 7.3 while the EC level is 0.9 (Table 1).

Water analysis: The results of the chemical analysis of Vedanthangal tank and Maduranthangam tank waters reveal that they differ in carbonate, sodium and calcium levels. The nitrogen (NO_2 & NO_3) and phosphorus (P_2O_5) content of the Vedanthangal tank water are 1.73/mg/l. and 4.4 mg/l. respectively (Table 1).

Analysis of guano: The chemical analysis of birds' guano for nitrogen (NO_2 and NO_3) and phosphorus (P_2O_5) reveals that it contains 29.9 mg/g. and 89.8 mg/g. dry weight respectively (Table 1).

The NPK levels of the soil of Vedanthangal tank ayacut and Maduranthagam tank ayacut differ significantly. Statistical analysis of comparison of means reveals that the nitrogen and phosphorus levels of Vedanthangal tank ayacut soil is higher than that of Maduranthagam. But the difference in nitrogen level is not statistically significant due to wide variation in the samples (P = 25%), whereas phosphorus shows a highly significant difference; 't' = 4.6 ($P<0.01$): n = 76. The potassium level of Vedanthangal is very low when compared to Maduranthagam tank ayacut soil; 't' = 8.66 ($P<0.01$): n = 76.

Fertility gradient: The fertility levels of NPK and levels of pH and EC of Vedanthangal ayacut soil reveal that a gradient is observed in pH, EC and phosphorus levels. It is observed that there is a gradual increase in the case of pH & EC and decrease in the case of phosphorus levels from ayacut soil near the tank to ayacut soil present at the extreme end of the tank.

Analysis of variance tested for phosphorus reveals that the values for the three different regions (0 to 100 m., 101 to 200 m., and 201 to 300 m) differ significantly ($P<0.01$) (Table 2).

TABLE 1

CHEMICAL ANALYSIS OF GUANO, TANK SILT, TANK WATER AND FIELD SOIL OF VEDANTHANGAL

Test	Guano (mg/gm dry wt.)	Silt* (kg/ha.)	Water (mg/lit)	Field (kg/ha.)
Nitrogen (NO_2 & NO_3)	29.0	1093	1.73	206
Phosphorus (P_2O_5)	89.8	106	4.40	130
Potassium (K_2O)	—	185	—	97

NOTE: * Silt of Maduranthagam lake contained 138 kg of N, 21.6 kg of K_2O/ha. and no P_2O_5.

DISCUSSION

It is a common belief among the villagers of Vedanthangal that the droppings of birds (guano) which fall into the tank water increase the fertility of the soil and also increase the crop production when used for irrigating their paddy fields. A majority opinion was that

TABLE 2

'ANNOVA' FINAL TABLE

P_2O_5 CONTENT OF THE SOIL — (SEE TEXT)

Source of variation	Sum of squares	df	Mean squares	'F' Ratio
Between columns	0.1072	2	0.0536	33.98
Within columns	0.0142	9	0.00157	$(P<0.01)$
Total	0.1214	11	—	

there was no need for fertilizer application when they were earlier cultivating the traditional paddy variety. Although the recent high yielding paddy variety needs addition of fertilizer, the addition of fertilizer for Vedanthangal ayacut may be lower than the amount of fertilizer applied in other areas.

Such an increase in fertility due to the addition of guano by water-birds was reported by Thangam (1956), Spillett (1966) and Santharam (1984) at Vedanthangal lake, by Hugh and Ganzer (1983) at Ranganathittu water-bird sanctuary, and by Salim Ali (1983) at Bharatpur Keoladeo National Park. Abraham (1973) reported that the yield of crop doubled in quantity on the application of guano-rich silt at Kanjirankulam ayacut.

Thus, fertility of the soil of these tank-irrigated land increases either by guano-rich tank water or by the addition of tank silt; in the latter, the guano settles and mixes with the silt. Here, an analysis of the fertilizing potential of the Vedanthangal tank water and silt will be noteworthy.

It was assessed during the peak period of the season (March 1984) that the tank water contains 1.73 mg/l. of nitrogen and 4.4 mg/l. of phosphorus. When this water is used for irrigating one hectare area of field and allowed to remain for height of 15 cm, its volume is 500 cubic metres (1,500,000 litres). Irrigation of this volume of water adds 2.6 kg of nitrogen and 6.6 kg of phosphorus to a hectare of area. In other words, it is equivalent to an addition of 5.56 kg of urea and 41.25 kg of superphosphate per hectare per irrigation by the same amount of water.

With reference to the tank silt of Vedan-

TABLE 3

INDIRECT FERTILIZER GAIN IN VEDANTHANGAL AYACUT — A COMPARISON WITH MADURANTHAGAM LAKE AYAKUT

Name of Fertilizer	Average level kg/ha.		Gain (V-M) kg/ha.	Source of chemical fertilizer	Gain in terms of chemical fertilizer (kg/ha.)
	Vedanthangal (V)	Maduranthagam (M)			
N	206	186	20	Urea (46% N)	43.5 (Urea)
P_2O_5	130	82	48	Super PO_4 (16% P_2O_5)	300 (Super PO_4)

thangal, it is assessed that it contains 442 kg/acre (1093 kg/ha.) of nitrogen and contains 43 kg/acre (106 kg/ha.) of phosphorus. In other words, one tonne of silt contains 440 g of N and 43 g of P. When an acre of land is raised by an inch height with this tank silt, it will add to the soil about 75 kg of N per acre and 7 kg of P per acre. (Note : It is said that 6 inch depth soil in an acre area of land weighs 1000 tonnes — Devadoss 1981). Thus it is evident that the addition of silt to agricultural land will increase the fertility of the soil to a considerable extent.

In this respect, an assessment of the indirect benefit received by the Vedanthangal farmers will be helpful to understand the usefulness of wildlife. A comparison of the fertilizer status (N and P) of the soils of Vedanthangal tank ayacut and Maduranthagam tank ayacuts will bring out the fact. (The latter tank is located about 1 km south of the former). It is seen that there is an increase of fertilizer (N and P) level in Vedanthangal tank ayacut soil, which is due to the addition of guano of the birds congregating there.

Although the levels of nitrogen in Vedanthangal ayacut and Maduranthagam tank ayacut do not differ significantly ($P>0.05$), my limited soil sample analysis showed a higher nitrogen content in the former. Further, the available nitrogen storage or its accumulation in the soil is not possible to an expected extent, as there is always a loss of nitrogen by evaporation and other means. Unlike phosphorus, nitrogen does not have the adhering capacity with soil particles. Thus nitrogen should be added for every crop.

It is evident that the guano deposits contribute mainly nitrogen and phosphorus and not potassium. The poor concentration of potassium in guano is evidenced from the studies of Raianu & Emanoil (1969), who showed that the fresh guano of Chiropterans contains 12.58% total nitrogen; 8.73% P_2O_5, 1.25% K_2O_5 and 3.16% C_aO. Further, the chemical analysis of guano of water-birds reveals that the contribution of phosphorus by the guano is more than that of nitrogen and the guano is considered to be the major source of phosphorus among the organic fertilizers (Cooke 1975).

Due to constant addition of guano by the increasing population of migratory birds at Vedanthangal tank, the water becomes highly concentrated and turbid. High turbidity was observed during March. During this period, the light penetration ranged from 30 cm. to 36.5 cm. with an average of 34 cm. depth. It is reported at Bharatpur Bird Sanctuary lake that a low light penetration up to a minimum of 46.78 cm. depth was observed during peak season (Ali 1983). The reason attributed by him is that the low light penetration may be due to thick growth of submerged vegetation. But in Vedanthangal Bird Sanctuary the low light penetration may be due to the mixing of large amount of guano and also to the presence of large amounts of blue-green and green algae.

Another point of interest observed during the course of the study is that there is a chemical gradient in the tank ayacut. Clear gradient is observed in the case of pH, EC and phosphorus levels (Table 2). No such gradient is observed in the case of nitrogen and potassium. During irrigation, the tank water is taken from one end to another by a canal. While doing so, the nutrient rich guano starts settling in the ayacut. The ayacut near the tank receives more concentration of the guano, which is reduced in the farthest ayacut as settling occurs while flowing. Although the guano contains both nitrogen and phosphorus. the gradient is not observed in nitrogen levels. This may be due to loss of nitrogen as already discussed. The ayacut located at the extreme end of the tank showed higher EC level compared to the ayacut near the tank. This may be due to reduced chance for proper drainage for the land located at the extreme ends.

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FOOD OF MALLARD, *ANAS PLATYRHYNCHOS* AT HOKARSAR WETLAND, KASHMIR[1]

G. MUSTAFA SHAH AND M. Y. QADRI[2]

(*With two text-figures*)

The food of mallard (*Anas platyrhynchos*) was determined during the shooting season from November, 1982 to April, 1983 at Hokarsar (34° 06′ N, 74° 05′ E; 1584 m. AMSL). Eighty mallards were obtained and their gut contents analysed. Plant material of 37 species formed 95.46% of the diet. *Oryza sativa* was the principal food and formed 47.01% of the diet. *Myosotis caespitosa, Echinochloa crussgalli, Myriophyllum spicatum* and *Najas gramineum* were the other chief dietary items. Very few invertebrates were consumed because of their limited abundance. The preference and relative intake appears to be directly related to the availability of food.

INTRODUCTION

Some three decades ago, mallard (*Anas platyrhynchos*) was one of the common breeding birds of the wetlands of Kashmir and was more or less resident (Bates & Lowther 1952). But the shrinkage of habitat as a result of reclamation and natural succession, illegal egg collection and unfriendly human behaviour have made its position precarious with the result that the birds no longer breed here and are only winter visitors to Kashmir.

In Hokarsar, mallard are very sensitive to changes in the habitat, including the availability of food. The number of birds that migrate to this wetland during winter is also declining greatly. In order to appreciate the significance of this species' habitat preference, population size and density, detailed information on the quality and quantity of food is important from a management point of view. It was with this aim that the present study on feeding habits was undertaken in an attempt to understand its food requirement, which is basic to the intensive management of any wild life.

STUDY AREA

Hokarsar (34° 06′ N lat., 74° 05′ E long.; 1584 m. AMSL) is an important and protected reserve for waterfowl, managed by the Department of Wildlife Protection, J&K Government, situated in the centre of the Valley, about 10 km to the west of Srinagar. The wetland is more or less semicircular in outline, extending in an east-west direction with a surface area of 9.0 sq. km. (Fig. 1). It is fed by a perennial Doodganga stream that originates from Doodganga watershed in Pir Panjal range of the Himalayas and drains into river Jhelum on the northwest by a small stream.

MATERIAL AND METHODS

Eighty mallards were collected from within the study area mostly by capturing and shooting. About 80% of the birds were shot and captured between 0900 hrs. and 1100 hrs. The entire gut of the bird was removed by the technique of Harrison (1960) and food contents

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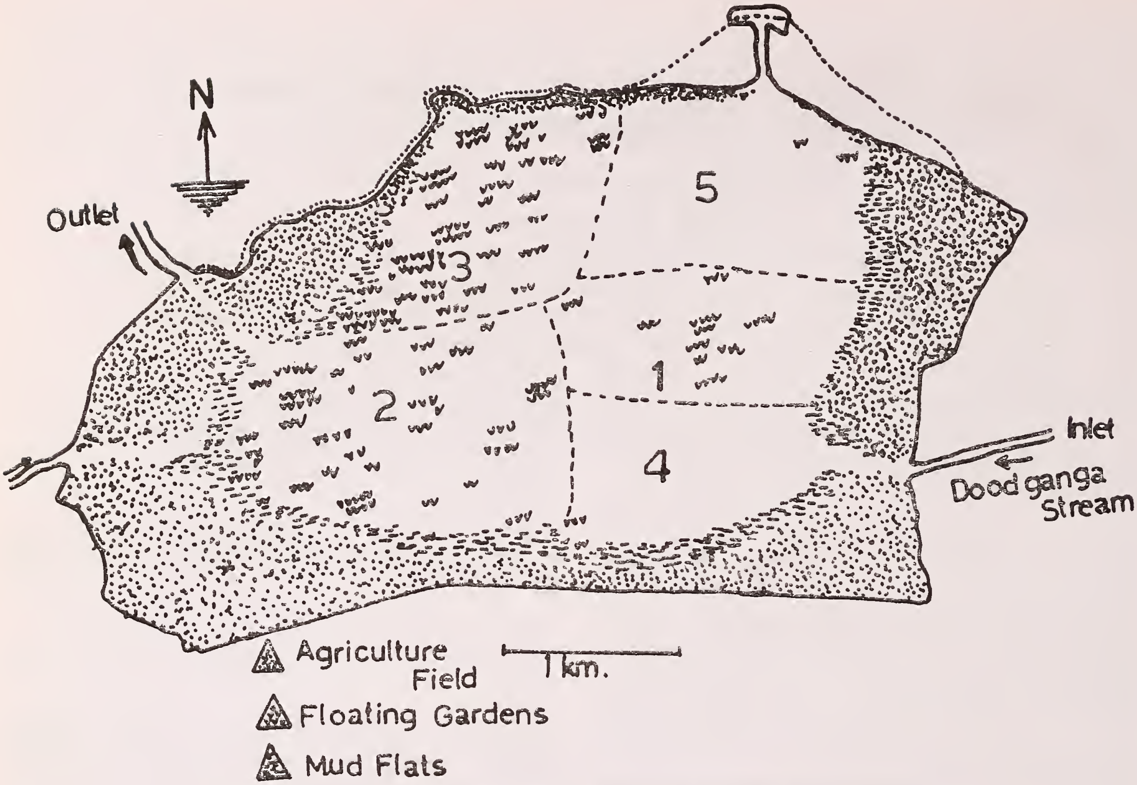

Fig. 1. Map of Hokarsar wetland reserve showing study units.

analysed. Guts which were not examined within six hours of collection were preserved in 4% formalin, after tying the severed ends of the oesophagus and intestine to prevent the loss of contents. Each gut was dissected and the contents of oesophagus and gizzard were washed repeatedly into sieves of various mesh sizes and sorted into organic and inorganic components. The organic material was further separated into animal and plant items and then identified as accurately as possible with the aid of Pennak (1953), Ward & Whipple (1959) and Martin & Barkley (1961). The weight of each plant and animal species, accurate to 0.005 gm. and the volume were calculated by water displacement method in graduated cylinder to 0.01 ml. after drying on a blotting paper.

RESULTS

Mallards started arriving at Hokarsar in small numbers in September and October and the maximum population was in November and December (Fig. 2). Due to cold temperature and paucity of food in January, a sudden decline in the population was noticed. But as favourable conditions returned in February, a build-up of the population was again noticed, which then gradually decreased in March and April before the birds left.

Mallard (*Anas platyrhynchos*) usually fed in small flocks or in pairs and in congregation with other ducks and geese like greylag goose, wigeon, pintail and common teal and was mainly a herbivore. The analysis of gut contents revealed the food to be composed

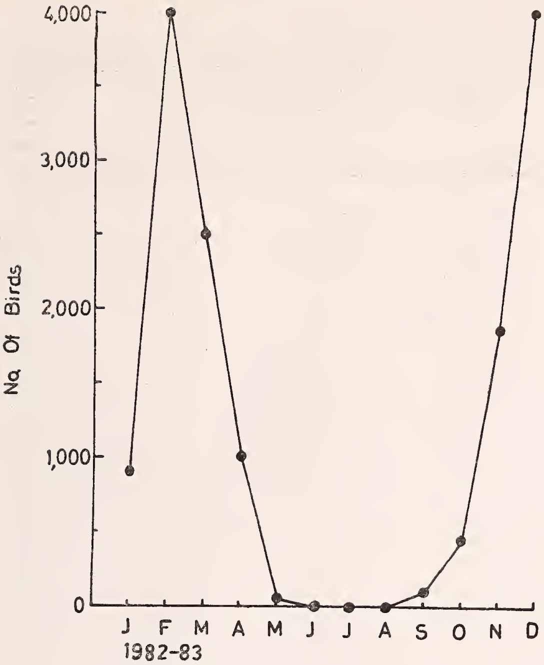

Fig. 2. Estimated population of the Mallard at Hokarsar.

of 37 species of plants and 15 families of animals. The food items with the frequency of occurrence, weight and volume are shown in Table 1.

The plant material comprised of seeds and fruits and other vegetable parts.

The seeds and fruits of 30 plant species belonging to 15 families contributed to the bulk of the diet and were recorded from 98.7% of the guts, forming 70.30% of the diet by weight and 68.43% by volume. *Oryza sativa* appeared to be the chief dietary item recovered in 66.2% of the guts and accounted for 33.7% of food by weight (32.5% volume). *Myosotis caespitosa* recorded in 78.7% of guts appeared to be slightly more preferred than *Oryza sativa,* but formed only 11.0% by weight and 10.40% by volume. *Phragmites communis* was found in 61.2% of the ducks and formed 4.81% of the total weight and 5.28% of the total volume. *Echinochloa cruss-galli* accounted for 4.66% by weight and 3.63% by volume. Seeds of five species of Cyperaceae were found in 85% and their combined weight and volume accounted for 2.50% and 2.47% respectively. *Myriophyllum spicatum* was recorded in 81.2% of the guts and formed 3.65% by weight and 3.47% by volume. *Najas gramineum* accounted for 3.47% by weight (2.86% by volume). In addition, seeds of 19 species of plants belonging to 11 families amounted to 5.88% by weight and 7.02% by volume.

Vegetative parts of 10 species of nine families were found in 46.2% of the guts and contributed 25.16% of food by weight (27.44% by volume). *Oryza sativa,* though recorded in only six birds, formed 13.31% of the total food weight (13.86% volume). This was followed by *Salix* twigs, which were recovered from seven birds and accounted for 4.63% of the total food by weight and 6.38% of the total food by volume. *Nymphoides peltatum* was recorded in four birds, being 2.42% and 2.20% of the food by weight and volume respectively. *Carex* sp., *Scirpus* sp., *Solanum tuberosum* and *Trifolium repens* were recorded in only 3.7% of the guts, *Lemna minor* and *Potamogeton* sp. in 2.0% and *Ceratophyllum demersum* in 1.2% of the guts.

The animal component of the food comprised of 15 species of animals found in 35% of the guts, contributing 4.54% of food by weight and 4.13% by volume. However, this consisted mainly of insects and molluscs. Two species of molluscs — *Lymnaea stagnalis* and *Lymnaea* sp. occurred in 12 guts. Ten species of insects, occurring in 1.2—8.7% of the guts, formed 3.98% and 3.53% of the total weight and volume. *Gammarus* sp. and Copepoda (Crustacea) were recorded in 5.0% of the guts and oligochaetes in 2.5%.

TABLE 1

ANALYSIS OF THE GUT CONTENTS OF MALLARD

Food categories	Frequency	% of total freq.	Weight (gms)	% of total wt.	Volume (ml)	% of total vol.
Fruits/Seeds						
Myriophyllum spicatum	65	81.2	14.59	3.65	12.64	3.47
Myosotis caespitosa	63	78.7	43.96	11.0	37.84	10.40
Najas gramineum	55	68.7	13.87	3.47	10.40	2.86
Oryza sativa	53	66.2	134.92	33.7	118.16	32.50
Phragmites communis	49	61.2	19.25	4.81	19.20	5.28
Scirpus setaceous	38	47.5	1.96	0.49	2.16	0.59
Sparganium ramosum	33	41.2	6.30	1.57	6.34	1.74
Eleocharis sp.	33	41.2	0.79	0.19	0.72	0.19
Carex nulbigena	31	38.7	4.80	1.20	3.44	0.94
Polygonum amphibium	30	37.5	0.43	0.11	0.48	0.13
Echinochloa cruss-galli	25	31.2	18.64	4.66	13.20	3.63
Polygonum hydropiper	16	20.0	0.09	0.02	0.24	0.06
Potamogeton natans	15	18.7	0.55	0.13	0.88	0.24
Potamogeton zizi	15	18.7	0.12	0.03	0.24	0.06
Potamogeton crispus	15	18.7	0.04	0.01	0.04	0.01
Unidentified	14	17.5	1.99	0.50	1.60	0.44
Eleocharis palustris	13	16.2	3.13	0.78	2.90	0.79
Polygonum patienta	13	16.2	0.04	+	0.02	+
Alisma plantago aquatica	12	15.0	0.30	0.07	0.80	0.22
Scirpus juncoides	11	13.7	0.06	0.01	0.16	0.04
Sagittaria sagittifolia	11	13.7	0.03	0.008	0.02	+
Hippuris vulgaris	11	13.7	1.09	0.27	1.30	0.35
Rannunculus muricatus	10	12.5	1.83	0.45	1.53	0.42
Nymphaea alba	9	11.2	2.31	0.58	2.20	0.60
Nymphaea candida	6	7.5	2.01	0.50	2.01	0.55
Trapa natans	5	6.2	0.60	0.15	4.00	1.10
Rumex conglomeratus	4	5	0.93	0.23	0.83	0.22
Nymphaea stellata	3	3.7	5.43	1.35	4.01	1.10
Rumex acetosa	3	3.7	1.29	0.32	1.01	0.27
Carex sp.	2	2.5	0.08	0.02	0.40	0.11
Fruits/seeds total	79	98.7	281.46	70.30	248.77	68.43

TABLE 1 (Contd.)

Food catagories	Fre-quency	% of total freq.	Weight (gms)	% of total wt.	Volume (ml)	% of total vol.
Vegetative parts						
Salix sp.	7	8.7	18.52	4.63	23.20	6.38
Oryza sativa	6	7.5	53.24	13.31	50.40	13.86
Nymphoides peltatum	4	5.0	9.68	2.42	8.0	2.20
Carex sp.	3	3.7	4.0	1.0	3.52	0.97
Scirpus sp.	3	3.7	5.09	1.27	4.23	1.16
Solanum tuberosum	3	3.7	8.20	2.04	7.53	2.07
Trifolium repens	3	3.7	0.92	0.23	0.81	0.22
Lemna minor	2	2.5	1.32	0.33	1.02	0.28
Potamogeton sp.	2	2.5	0.09	0.02	0.02	+
Ceratophyllum demersum	1	1.2	1.33	0.33	1.03	0.20
Vegetative total	37	46.2	102.40	25.16	99.76	27.44
Animals						
MOLLUSCA						
Lymnaea stagnallis	12	15	1.03	0.26	0.93	0.25
Lymnaea sp.	10	12.5	0.44	0.11	0.41	0.11
ARTHROPODA						
INSECTA			13.69	3.98	12.95	3.53
Bagus sp.	7	8.7	11.23	2.80	10.40	2.86
Cricotopus sp.	4	5.0	0.82	0.20	0.80	0.22
Chironomid larvae	4	5.0	0.33	0.08	0.31	0.08
Cybister lateralimarginallis	3	3.7	0.88	0.22	0.75	0.20
DIPTERA (pupae)	3	3.7	0.23	0.58	0.24	0.86
Gerris sp.	2	2.5	0.17	0.04	0.16	0.04
Macromia sp.	2	2.5	0.10	0.02	0.08	0.02
Hydrophilus sp.	2	2.5	0.08	0.02	0.07	0.02
Laccophilus minutus	1	1.2	0.07	0.01	0.08	0.02
Syrphid larvae	1	1.2	0.07	0.01	0.06	0.01
Crustacea						
Gammarus sp.	4	5.0	0.72	0.18	0.69	0.18
Copepoda	4	5.0	t	+	4	+
Oligochaetes	2	2.5	0.03	+	0.03	+
Animal total	28	35	16.12	4.54	15.01	4.13

Total food weight = 399.89 gm   Average 4.99 gms/gut
Total food volume = 363.54 ml   Average 4.54 ml/gut
+ = <0.01%   t = <0.0050 gm and <0.01 ml

DISCUSSION

Waterfowl, in their cyclic migration, experience changing conditions not only among the wetlands and other water bodies but also seasonally within a given ecosystem. A recent extensive accumulation of information on the feeding ecology of waterfowl has indicated that the diet of species changes with availability, time, age and even sex (Sugden 1969, Swanson & Meyer 1973). Mallards, in their search for food, are constantly faced with changing conditions in the complex of aquatic ecosystem. The rapid changes in environmental conditions, such as climate, influence their occurrence in the wetland more than any other factor (Swanson *et al.* 1974). During December, when a peak population of overall waterfowl as that of mallard (over 4000) was built up, there was an intensive competition for food, with the result that the quantity and availability of food became a limiting factor. The availability of food was also affected by severe cold — freezing of the water and snow cover formed on the ground and floating vegetation. This led to a great fall in the population of birds under such conditions. Maitland (1964), Krapu (1974) and Owen & Cook (1977) have suggested the low availability of fauna and other surface food during the extreme cold of winter as the factor limiting the population of mallard. Although mallards are generally equipped to withstand the low temperature the conditions with regard to procurement are not favourable, and hence the exodus from the wetland. Cains (1973) and Bennet and Bolen (1978) also showed that severe weather conditions especially low temperature of January and food shortage are known to cause stress and affect the distribution and movement of mallards. With the improvement of conditions in February, the mallard population reformed again. So differences in the diet reflect the differences in the availability and possibly differing abundance of foods in the different periods as also suggested by Olney (1967) and Thomas (1982).

Although some parts of as many as 37 plants and 15 animal species were recorded in the gut contents of mallard, only a few of these formed the major items, and the feeding habits provided sufficient evidence that mallard changed its feeding habits with season during its stay at the wetland. The variations in the diet may also be due to the presence of some superabundant farm foods (Owen 1976). *Oryza sativa*, which was the major food item of the bird, is knocked to the ground during harvesting in autumn and gets washed into the wetland due to rains and is available to the duck. The preference, and therefore relative intake, appears to be directly related to the availability of food. They seemed to prefer mainly seeds when freely available; on other occasions they would shift to other vegetation and animal matter. These seasonal variations are similar to those described for the species in North Queensland (Lavery 1966).

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OBSERVATIONS ON THE OCCURRENCE AND HABITS OF THE *NACADUBA* COMPLEX OF THE LYCAENIDAE (LEPIDOPTERA), MAINLY FROM PUNE DISTRICT, WESTERN GHATS[1]

A. E. BEAN[2], S.S.J.E.

(*With sixteen plates and seven text-figures*)

The taxonomic work of Eliot (1973) stimulates the interest of the field naturalist. Distribution of the 71 species is tabulated and the possible origin and spreading of the group is suggested. Field observations on eight species from India and Sri Lanka are given, with notes on some early stages. The male genitalia and androconia are described and illustrated. Notes are added on the preparation of male genitalia.

CLASSIFICATION

For the purpose of this paper I include in '*Nacaduba* and allied genera' those listed by Tite (1963), adding the single African genus *Pseudonacaduba* as in Eliot (1973) who divides the group as follows:

a) *Petrelaea* section:	
Pseudonacaduba Stempffer, 1943.	African
Petrelaea Toxopeus 1929	Oriental
b) *Nacaduba* section:	
Nacaduba Moore, 1881	Oriental
Prosotas Druce, 1891	„
Paraduba Bethune-Baker, 1906	„
Ionolyce Toxopeus, 1929	„
Erysichton Fruhstorfer, 1916	„
Catopyrops Toxopeus, 1930	„

Eliot gives the following features generally common to the whole group: Veins 11 and 12 of the forewing are usually fused for at least part of their length. The eyes and the palpi are hairy. There are usually androconial scales on the upperside of the male forewings.

The two sections of Eliot, *Petrelaea* and *Nacaduba*, are sharply divided by clear differences in the genitalia (see Table 3).

In general appearance both sections are broadly similar, especially in the females. Males can often be distinguished by facies alone, but a close look with the lens is always necessary.

The position of the Nacaduba *complex in the Lycaenidae*:

The 'Nacadubas' belong to the subfamily Polyommatinae Swainson, 1827, the so-called 'Weak Blues'; Eliot places them in the tribe Polyommatini Swainson. Since this unwieldy tribe does not fall into natural groups he divides them into thirty sections, mentioning where he considers them taxonomically close. The 'Nacadubas' fit into the tribe as follows:

The *Una* section is Oriental (Assam-Burma) and fairly close to the *Petrelaea* section. Next to *Petrelaea*, but not necessarily very close, comes the *Nacaduba* section, and this seems to be linked to the Oriental *Upolampes* section by the Papuan and Australian *Theclinesthes* section.

To the ordinary field naturalist, all this may seem a dry taxonomical bone. Yet two butterflies well known to him are now included in this *Upolampes* section; *Castalius caleta* and *Castalius ethion*, which should now be called *Caleta decidia* and *Discolampa ethion*. Thus

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TABLE 1

DISTRIBUTION

A. *Pseudonacaduba* Stempfer, 1943.
African, two species, from Sudan southwards to Transvaal; Madagascar.
B. *Petrelaea* Toxopeus, 1929.
Oriental, one species, ranging from India to the Solomons.
C. *Nacaduba* Moore, 1881.
(i) The Indian peninsula and Sri Lanka:
pactolus; extends through AB & Mal. to Torres Str., Phil. & Taiwan.
hermus; through AB to Mal. Phil. Moluccas.
olyetti; Sri Lanka only.
berenice; to AB, Mal., Phil., Moluccas, Aust., Solomons.
sinhala; Sri Lanka only.
kurava; to AB, Sul., Pap., C. York, Arnhemland, Solomons, Japan.
beroe; Sri Lanka. (apparently *not* peninsular India) AB, Mal., Phil., Taiwan.
calauria: Sri Lanka (*not* India) Mal., Moluccas.
(ii) Assam, Burma, Malaysia, Papua, Australia, Melanesia, Polynesia:
Twenty-nine species.
D. *Prosotas* Druce, 1891.
(i) The Indian peninsula and Sri Lanka:
nora; Assam, Burma, Malaysia, Philippines, Cape York, Taiwan.
dubiosa; Assam. Burma, Malaysia, Papua, Queensland, Solomons.
noreia; Assam, Burma to Malaysia.
(ii) Kumaon, Assam, Burma, Malaysia, Papua, Australia, Taiwan:
Fifteen species.
E. *Paraduba* Bethune-Baker, 1906:
Three species, Papuan.
F. *Ionolyce* Toxopeus, 1929.
(i) The Indian peninsula and Sri Lanka:
helicon; to Assam, Burma, Andamans, Nicobars, Malaysia, Queensland. Torres Strait.
(ii) *brunnescens* Tite, 1963. Solomons.
G. *Erysichton* Fruhstorfer, 1916.
Three species: Moluccas, Papua, Queensland.
H. *Catopyrops* Toxopeus, 1930.
Five species: Burma, Malaysia, Papua, Solomons, Queensland, New South Wales.

Notes to Table 1.

This Table attempts to give a general picture of the distribution, showing that the greater number of the sixty-nine species is found in SE Asia. Many of the widely distributed species have formed subspecies.

Abbreviations:
AB — Assam-Burma.
Mal. — Malaysia.
Phil. — Philippines.
Sul. — Sulawesi (formerly Celebes).

these familiar jungle insects turn out to be quite near the 'Nacadubas' and a long way from their former neighbours like *Castalius rosimon* and *Tarucus,* typically plains insects. This is just one example of how the attitudes of the field naturalist and of the laboratory worker support and complement one another.

ZOOGEOGRAPHY

When one has been privileged to encounter a few members of an intensely interesting group in the field, questions about their origin and evolution press for an answer. In the nature of things, absolute certainty is unattainable, but it would be a poor response to the complex beauty of these little creatures if one shirked the risk of a few guesses.

So I imagine myself back on a rather denuded part of the Western Ghats. There is *nora* — (or *dubiosa*; I hope, *noreia*) — dashing around an acacia bush in the midday heat along with three kinds of *Azanus* and a *Rapala.* How did these forms get here? During what unimaginable time have they been going through a cycle of courtship, egglaying and growth, in dependence on a plant like this, with ants like these busily walking about its twigs and blossoms?

Now I move on into deeper forest, into remains of climax jungle . . . how long has *pactolus* been living on and on in this tiny area where I stumbled upon it twenty years ago? Those great *Entada* limbs must have been seedlings in Shivaji's day; but the lianas of those times would only take you back another three hundred years. We have to peer back far beyond this . . . It is time to look calmly at the question of the origin and evolution of the butterflies, and to see if there can be any justifiable guesses about the 'Nacadubas'.

There is only the scantiest fossil record for the butterflies, from the early Tertiary, around fifty million years ago. A few actual butterflies have survived in the Baltic amber, from the mid-Tertiary; these and the fossils are referable to existing families. But recently a probable Lepidopteron from the Triassic, around 200 million years ago, was described from a fossil. So far, this fossil from Australia is the only actual evidence of the development lying behind our present Lepidoptera. [Authority quoted by Higgins (1975): 31].

The picture can, however, be filled in to some extent through recent work on the early history of the planet, especially the now well established phenomenon of Continental Drift. [See Eliot (1973): 457-465]. In what follows, I am greatly indebted to Col. Eliot's paper; any mistakes and misinterpretations are my own.

Eliot (op. cit.): 460, giving his authorities, places the origin of the butterflies, as a Suborder, in the late Mesozoic era around the middle of the Cretaceous period, about a hundred million years ago. (For a time scale, see Table 2 throughout). The most likely area for the emergence of the group would be the enormous southern continent of Gondwanaland; it was mostly tropical; later enormous forces would break it up into the present lands we know as Africa and Madagascar, India and Sri Lanka, South America, Australasia and Antarctica. (Plate II).

During the Cretaceous the climate was warm, the lands flat and close together, the seas at their maximum. Generations of tiny molluscs were depositing their shells on the sea beds, laying down the chalk. On land, the giant Dinosaurs were nearing their rather sudden extinction. Flowering plants were evolving in symbiosis with the new nectar-sucking bees and Lepidoptera.

Such was the world of the first butterflies. Among them would be the Lycaenoidea, from which would develop — when, we cannot tell — the two groups Riodinidae and Lycaenidae. From the vast, tropical spaces of Gondwanaland it would have been easy for butterflies to colonize the northern landmass of Laurasia where the climate would be at least partly subtropical. Laurasia included what are now North America, Greenland and Eurasia, and was attached to the northwest of Gondwanaland where Spain now faces Africa, and at various points west.

Thus one can accept that in the mid-Cretaceous there were no ocean barriers prohibiting the colonisation by butterflies of all suitable land. The fossil record bears this out; at this very time the marsupials spread worldwide.

Before the end of the Cretaceous, a major rearrangement of the land-masses began, due — it is now widely held — to the action of Continental Drift. The process still continues today, at rates varying from 12 to 150 millimetres a year. The rock plates of which the earth's crust consists tend to push over one another, riding upon the viscous mantle which supports them. In this way the land surfaces which appear so stable to the senses are, in fact, on the move, and get carried long distances in the course of a few million years.

By about 90 million years ago the south American part of Gondwanaland had drifted westward; Antarctica, with Australasia, southward; India, perhaps with eastern China, northeastward across the immense Tethys Sea. Thus the African heart of disintegrating Gondwanaland would still contain the majority of Lycaenid forms. Since India had become isolated in the ocean, probably long before the mid-Cretaceous, it is unlikely to have had 'a Lycaenid fauna until its northward drift brought it close to, or even in contact with, Eurasia'. [See Eliot (1973): 461]. The same would apply to Australasia; Australasia and India would have had rather cold climates until they came near or fused with Eurasia. On the other hand, Eurasia in Cretaceous and Paleocene times was further into the tropics than it is today, and was in close contact with Africa through the Gibraltar link. Thus in the early Tertiary many Lycaenids could have reached even southeast Asia — at a time when India had not yet arrived at its present location.

By about 65 million years ago, during the Tertiary, Eurasia began to get colder as the result of a northward drift. Also the Sahara desert was appearing. This meant that tropical Africa, with its Lycaenids, became isolated on all sides. Especially in the rainforests, ancestral populations continued to develop for the next 60 million years or so.

Then, at the end of the Tertiary, the Himalayan upsurge began. This was the most momentous of all earth changes for present life forms. Enormous bucklings and foldings of the rock pushed up chains of new mountains from what had been a comparatively flat world. Their still jagged and unworn ridges, so unlike the ancient profile of the Ghats, include the highest points on this planet, and sweep in a great curve from Papua to the Alps.

For the Lycaenidae this meant they ceased to be isolated, and would soon have new lands before them. Drift and other earth movements fused India with Eurasia and formed a middle eastern link with northeast Africa. The Tethys ocean therefore was no longer a barrier; land near its northern shores would now become a bridge. (See Table 2).

The juncture of India may not have been completed until ten million years ago, and another five million may have passed before the Australasian group arrived near its present position. But as soon as the ancient Indian island had settled as a peninsula south of the new Himalayas, something like the present climatic rhythm would have begun. Many Lycaenidae would now have been able to enter India from Africa through the northeast link, and in the course of time adapt to new conditions — from plains to hills, from rain forest to monsoon forest. Their infiltration would not have been difficult, since the middle East was not yet largely desert, nor broken up by the Red Sea and the Persian Gulf. Even now there may be some transfer of Lycaenids by this route still going on. See Eliot (op. cit.): 461. For instance, two Thecline genera which can put up with at least semi-desert conditions are *Aphnaeus* and *Spindasis*; among Polyommatinae, *Azanus*, and, I would suggest, *Zizeeria* and *Freyeria*, are about as desert-tolerant as small butterflies can be; *A. jesous* is found all the way from north Africa to Burma. The present distribution of species in the *Spindasis* group is notably in favour of transfers from Africa eastwards. We should not have in mind a picture of migration, but rather of questing and testing, over immense periods, and literally from bush to bush.

But in Eliot's opinion the 'Nacadubas' did not reach India by the north African route. Compared with the *Theclinae* they are weak flying and of delicate structure, yet they have reached Queensland in some cases and even New South Wales. New Guinea and Melanesia are full of them; a glance at Table 1 shows their heartland is southeast Asia. In contrast, really tough creatures like *Spindasis* have not crossed Weber's Line. See Plate I and Eliot (op. cit.): 462; their present distribution adds weight to the belief that they belong to the north African movement. Along with other Lycaenid groups they reached southeast Asia through India in 'post-Miocene times and ... underwent secondary development in India ... and the Sino-Himalayan subregion.' (Eliot, loc. cit.). There are about fifty *Aphnaeus-Spindasis* species in the Ethiopian Region, and only fourteen in the Oriental. But the latter differ little from their African relations, so, as Eliot says, long isolation is out of the question.

In contrast, there are over sixty species of the *Nacaduba* complex in the Oriental Region, of which only a dozen occur in India and Sri Lanka, and a mere two in the Ethiopian Region. Eliot believes that the ancestors of *Nacaduba* and some other Polyommatine groups reached tropical Asia from Gondwanaland right back in the Cretaceous. They developed there until the Pliocene, a moderate number of forms reaching India after its fusion with Asia.

Eliot refers to the belief of Zeuner and others that there was a Protopapua, covered with rainforest, north of the present site of New Guinea and connected with the Asian mainland by strings of islands. Protopapua is thought to have lasted from the early Tertiary until the mid-Miocene, when the mountains of New Guinea began to appear as a result of the great upsurge. Both lands may have co-existed for a time, allowing butterfly populations to transfer. See Eliot (op. cit.): 463, and passim. Even without a Protopapua there must have been vast areas in Asia where 'Nacadubas' could have proliferated and formed species, especially in conditions of isolation. And there was plenty of time for it, probably some forty million years.[3]

Eliot, therefore, has not simply made deductions from present distribution; he has given us a brilliant reconstruction of the butterfly past, using the few but significant probabilities of prehistory in conjunction with the meagre fossil record.

The 'Nacadubas', being rather sessile creatures, have a tendency to form races, and these are likely to be incipient species. This tendency has been encouraged by changes in sea level during geologically recent times. From about 240,000 years before the present, until about 180,000 years BP, there occurred the last of the Pleistocene glaciations in the northern hemisphere.[4] The ice held up so much seawater that the Sunda and Sahul Shelves in the shallow Indonesian and Australian seas were exposed. (See Plate I). The new land developed rainforest, the Sunda forest being about a million square miles in extent. When the ice receded, releasing the seawater, numerous islands remained and are still there, with the remnants of their rainforest. As long as man does not ruin them, these relict environments will continue to foster speciation. Thus there are five or six races of *Nacaduba astarte* on closely adjacent islands or groups of islands in the Solomons and Bismarcks. See Tite (1963): 76, and Plate III.

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[3] It is usually held that a species may evolve in from half a million to one million years, and a subspecies in about ten thousand years.

Even if new evidence should modify Eliot's conclusions, his main theme will stand, based on the near certainty that during the Mesozoic the continents were also together if not completely united. The existence of Gondwanaland during this era seems proved by the distribution of *Lystrosaurus*, a small freshwater reptile, in the Triassic beds of both Africa and India. Recently it has been discovered in the Antarctic. Another reptile, *Mesosaurus*, from the Permian, links southern Africa and Brazil. A Permian plant, *Glossopteris*, has long been known from all the components of Gondwanaland. The parts of Laurasia are linked by equally impressive evidence from fossil reptiles and amphibians. See Colbert (1973):

On this basis, therefore, it is clear that the Butterflies, including the remote ancestors of *Nacaduba*, could have been flourishing in the former great Gondwanian continent towards the end of the Mesozoic. They could have reached southern Asia as early as the Cretaceous, when all the lands were still close together, and continued to evolve over these very lengthy periods. They Polyommatine genera, perhaps with *Nacaduba* among them, spread first to the Papuan subregion, and later, during the major earth changes of the Tertiary, arrived in India.

Note on the Photographs of Adults.

The specimens used for *Nacaduba beroe* (male) and *N. sinhala* (male) on Plates VII and X have lost the filamentous 'tails' at v. 2 of the hindwing.

Apart from these the Plates depict species actually either tailed or tailless.

Notes on some species from India and Sri Lanka

I. **Petrelaea dana** (DeNiceville, 1883) (Plates V & VI)

This is a wide ranging species, from India to the Solomons, but it has not been possible to define any geographic races [Tite (1963): 109]. It is uncommon in the places I have visited, and I saw it on only two occasions. The first was, surprisingly, in a crowded part of Bombay city when I took a male fluttering over garden beds in St Peter's School compound, which lies immediately below a small eminence known as Mazagaon Hill. At that time (January, 1953) there was a good deal of rough ground there apart from the public gardens, also a water tank and many trees, so the hill was attractive to butterflies. Although only a few metres high, it constitutes a land mark for insects crossing Bombay harbour or working in through the suburbs from the Salsette jungles. I believe a good deal of migration in the full sense, and also drifting, takes place from Salsette out to Malabar Hill; I have caught or observed several butterfly species,

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[4] Not the more localized glaciation, often called 'the Ice Age', of 120,000 to 22,000 years BP.

TABLE 2

TIME SCALE, BASED ON COLBERT (1973): 24

Era: Length in millions of years	Periods and Epochs	Duration in millions of years	Duration, before the present	Events and Life forms
Cenozoic 65	*Quarternary*:			
	Pleistocene	3	20,000–3 mill.	Man.
	Pliocene	9	3–12	Australia near present position.
	Miocene	15	12–27	Juncture of India. New Guinea replacing Protopapua.
	Tertiary:			
	Oligocene	10	27–37	Modern mammals. Himalayan upsurge beginning.
		FOSSILS OF LEPIDOPTERA.		
	Eocene	18	37–55	Flowering plants dominant.
		LEPIDOPTERA & APOIDEA established.		
	Paleocene	10	55–65	Primitive mammals. ? Protopapua.
Mesozoic 160	*Cretaceous*	70	65–135	Ancestral mammals. Flowering plants begin.
	Jurassic	60	135–195	Giant Dinosaurs. First birds. Dragonflies Grasshoppers Sawflies. ? Ants.
	Triassic	30	195–225	First Dinosaurs. Conifers, Cycads, Small Ferns, Gingkos.
		Fossil of a(?) Lepidopteron from Australia.		
Paleozoic 375	*Permian*	55	225–280	Early Reptiles.
	Carboniferous	65	280–345	Large Amphibians, Early Plants, Beetles, Bugs, Cicadas.
	Devonian	50	345–395	First Insects — *Aptera*.
	Silurian	45	395–440	First backboned animals.
	Ordovician	60	440–500	
	Cambrian	100	500–600	
		Precambrian time about 3½ billion years.		

including Lycaenids, which can hardly be resident in the city or are not proved to be so. This has been noticed by Sanders (1955). It is on the other hand possible that there are small relict populations from former jungle or in surviving jungle within the city limits. One such place which I was able to visit on rare occasions is Governor's Beach on Malabar Hill, where I saw the magnificent Great Orange Tip *Hebomoia* for the first time. It would be good to seek permission to investigate this area. As for *Petrelaea,* until there is further information it should be regarded as a stray in the city, and searched for in Salsette localities like Vihar and Powai.

My second encounter with *Petrelaea* was on Katraj Ghat near Pune at *c.* 850 m., where I took a male at a damp patch in October, 1961. I would say this was a typical habitat. Bell (1918): 653 implies that it is rare or local on the Western Ghats. He says it is especially fond of *fresh* cattle droppings, so these should be watched. (Many Lycaenids will never be noticed at all until one hits upon the exact places which attract them, or which the great naturalists, like Bell, have already discovered).

The species may be commoner farther south on the western Ghats. My friend Mr. A. J. Sharman found it abundant at about 1370 m. in the Biligirirangan Hills. Karnataka, in May 1957 along forest streams; at Kallar in the Nilgiris at *c.* 370 m, in April; localities in the Palnis at *c.* 2134 m. in May and August; and a place in the Tirupati Hills (Eastern Ghats) at about 400 m. in June. All his specimens were males taken at mud; he saw no females anywhere. Dr T. Norman, who most kindly gave me a male from Assam and a female from Manipur, said that the female is rare in the Assam Valley plains. Woodhouse & Henry (1942): 91 state that the species is never common but occurs all over Sri Lanka below *c.* 460 m. all the year round. The males come to damp spots; the females are very rare.

Unless rearing from the early stages should prove otherwise, I think it preferable to say that the female of *Petrelaea* is rarely taken; it probably has skulking habits and lays its eggs on plants growing in out-of-the-way places, which would explain why the early stages have not been observed. The sexes appeared in about equal proportions in the two *Nacaduba* and the two *Prosotas* species of which I have some rearing experience.

It is interesting that the upperside blue of the male is fairly bright and clear, similar to that of the African *Pseudonacaduba sichela.* How closely *Petrelaea* and *Pseudonacaduba* may be related is a matter for argument; their genitalia are different except for one striking similarity. See Eliot (1973): 379, where he says it is unwise to give absolute primacy to any one character.

The Androconia

These are specialized scales found in patches or scattered on the wings of male butterflies of several families, including the Lycaenidae. Their occurrence in any Lycaenid genus seems random. Their physical structure, when seen with the scanning electron microscope, has often been found to differ from the ocular view; see Eliot (1973): 399. They are taken to be scent scales.

In *Petrelaea* the androconia are club-like and remarkably long for a small butterfly [see Plate IV: 4 and 4(a), the latter figure drawn at a lower magnification in order to include the whole.] Such scales are found in a few other species: *Erysichton lineata* (Murray) of the *Nacaduba* complex, where they are quite twice as large as in *Nacaduba*; see Tite (1963): 102. A *Jamides* species; see Eliot (1973): 406. *Azanus ubaldus* Cr. where they are about the same length as in *Petrelaea.* The occurrence of scales of this type seems random, although one could say that the first three are not too widely separated in classification. *Azanus* is shown on Plate IV: 5 at the lower magnification.

The androconia of *Petrelaea* appear to have eight or ten longitudinal ridges, judging from the four spaces usually visible between the ridges. Scattered along these ridges, mainly at the broader end, appear to be nodules or pits. In view of what is said above about the physical structure, all statements here are provisional. The drawings show what is seen with the ordinary microscope; except for the two cases noted above they are all at the same magnification, done with a *camera lucida* arrangement devised by Mr. Tite.

The precise use of the androconia has not been observed in the Lycaenidae so far as I know; almost certainly they are scent producing scales used in courtship. Tinbergen (1974): 138-157 describes the arduous investigations needed to discover the role of scent in the courtship of a Satyrid butterfly in Holland. No less perseverance will be needed if anyone with the opportunity is to do similar work with Lycaenidae.

The Male Genitalia

I include here some general remarks applying to all the genitalia studied here. Particular statements apply only to *Petrelaea. The Aedeagus* (a word perhaps connected with Latin *aedes,* meaning a house) is the hard outer casing or housing of the penis. In this small species it is *c.* 1.75 mm long, as compared with *c.* 0.9 mm in the large species *Nacaduba pactolus.* The *ductus,* the duct leading from the seminal vesicles, enters the aedeagus ventrally in *Petrelaea,* dorsally in the *Nacaduba* group. In Plate X: 6 the ductus is shown by broken lines on the left, near the base of the aedeagus, the pointed organ which reaches diagonally across the figure. Since the ductus is of soft tissue, or only lightly reinforced, I have not been able to retain it in any of my dissections. (The genital organs are made of the same sort of hard material, known as chitin, which support the insect body, so that only the soft parts, muscles and ligatures, are lost when making a microscope slide). The aedeagus in *Petrelaea* has no Chapman's process; this is a feature of many species of the *Nacaduba* section, arising ventrally from the upper part of the aedeagus. In *Petrelaea* there is a dorsally placed organ, shown in side view in the figure. A dorsal view shows that this feature grows from the surface of the aedeagus about halfway up, and ends about 2/3 of the way along towards the tip. This process ends in the shape of a two-pronged fork sloping a little away from the surface of the aedeagus (See Fig. 1).

The Uncus (Latin = hook or barb) is attached to the dorsal side of the genital ring. In most Lycaenid genera the uncus is divided into two lobes (labides), each of which bears a curved brachium (Latin = arm). The latter are better referred to as *falces* (Latin falx = sickle) which describes their usual shape.

In Plate X: 6 only the right labis is shown. There does not seem to be anything special about these structures in *Petrelaea.*

The Valvae (valves, clasps or claspers) are attached to the ventral side of the genital ring. Higgins (1975): 95 says they are not well named as clasping organs since they are relatively immobile. At the base of the valvae is the furca or fork, known also as juxta or join. Its function is to help support the aedeagus. In Plate X: 6, the furca is shown in position; it is not clearly seen by transparency in the slide. Plate X: 7 shows the inside of the right valve; in *Petrelaea* the hook at the valve tip is directed ventrally. In Plate X: 6

the nearer valve is rather edge-on, but the other valve shows the true direction of the hooked tip.

The Vinculum (Latin = bond or fetter) is the genital ring, actually U-shaped, to which the labides are attached dorsally and the valvae ventrally [See Higgins (1975): 27, 95-96].

In *Petrelaea* the process from the vinculum known as the *saccus* is well developed, extending forward into the abdominal cavity, evidently in order further to stabilize the genital armature. The word *saccus,* meaning 'bag', is therefore not apt, although it is the name in use. A long saccus seems (understandably) to go with a long aedeagus [Higgins (1975): 28].

II. **Nacaduba pactolus continentalis** Fruhstorfer, 1916.

(Plates VI & VII)

This fine species ranges in a number of forms from the Western Ghats to the Torres Straits, and from Sulawesi to Taiwan, trenching both on the Palaearctic region and on the Australian part of the Oriental region. The race *continentalis* occurs rather rarely from Burma westward, but is not rare in the Khasis [See Cantlie (1952): 52]. Dr T. Norman told me that it was quite common in the 1960's in the Khasi Hills, flying up to *c.* 1200 m. H. C. Tytler (*JBNHS* 21: 595) reported it up to 1500 m. in the Nagas. Bell found it in the Karwar jungles in the 1920's, and probably reared it, since there are pupa skins under two of his specimens in the collection of the Bombay Natural History Society; no other information was found.

I had the good fortune to be able to rear it from a colony discovered in the neighbourhood of Khandalla, 500-700 m., Western Ghats, as recorded in Bean (1965): 614-626. The following assesses the information obtained:

Bell's material, cited above, shows that in Karwar the butterfly appears in the hot season (March-May); Tytler, as above, reported it for July; material in the collections of the British Museum (Nat. Hist.), of the Bombay Natural History Society, and of the Hope Collections, Oxford, also bears hot-season dates and, in some cases, of the post-monsoon period. But these times of appearance differ in the Khandalla region; I never

TABLE 3

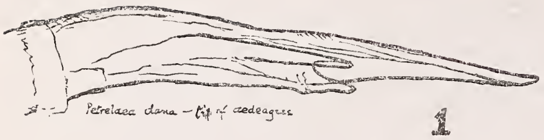
COMPARISON OF THE MALE GENITALIA IN THE *Petrelaea* AND *Nacaduba* SECTIONS.

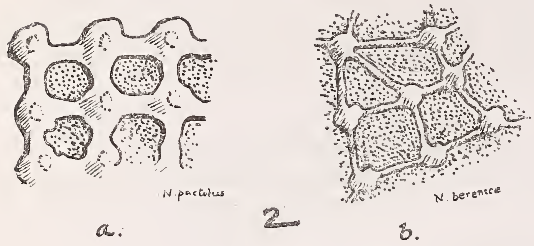
Petrelaea section	*Nacaduba* section
Aedeagus:	Aedeagus:
a) Long.	a) Short.
b) Ductus enters ventrally.	b) Ductus enters dorsally.
c) Subzonal and suprazonal portions about equal.	c) Suprazonal portion shorter.
d) No coecum.	d) A short coecum usually present.
Vinculum:	Vinculum:
Saccus developed.	Saccus not developed.

Notes to the above:

The Zone (Greek = 'girdle') is the point at which the penis is fixed to the inside of the aedeagus. Its position can usually be seen, but is hard to depict in a line drawing.

The Coecum (Latin = 'blind') refers to the basal part of the aedeagus.





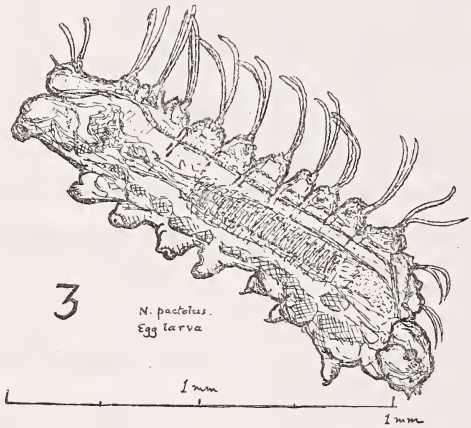
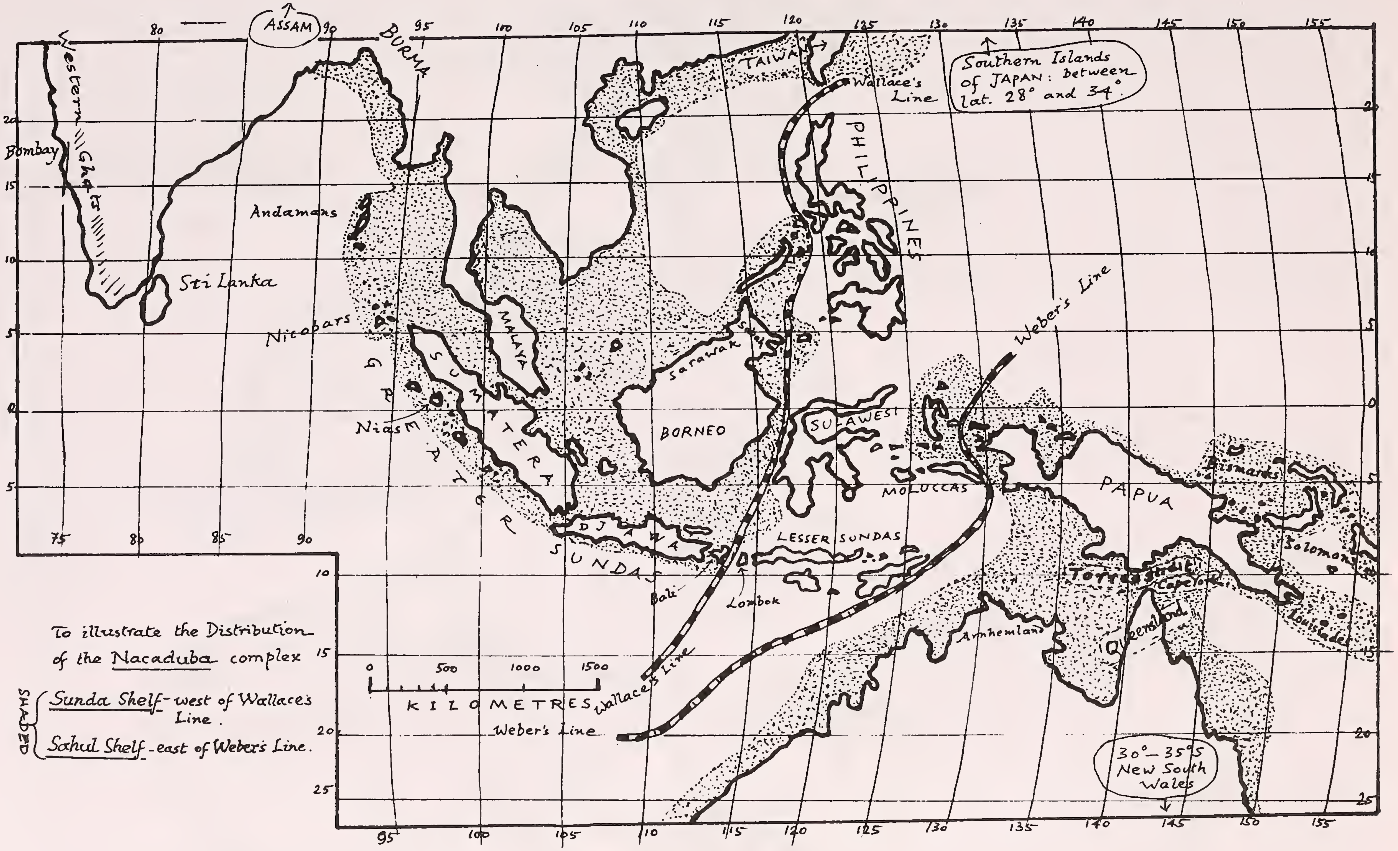


Fig. 1. Tip of the Aedeagus, *Petrelaea dana* (Diagrammatic). Fig. 2. Sculpture on the egg: a) *Nacaduba pactolus*; b. *N. berenice*. Fig. 3. Egg-larva: *Nacaduba pactolus* — W. Ghats, Sept., 1964.

saw the insect there between December and July. Between 1956 and 1964 I was able to make careful observations at intervals of two or three weeks, which indicated that *N. pactolus* is an entirely monsoon and post-monsoon insect in its Khandalla locality. It would seem that conditions are not damp enough there for it to develop adults in winter and spring as, for instance, *N. berenice* is able to do. The *pactolus* larvae need the tenderest leaves of the food plant, preferably the youngest red ones, which are photosynthesizing at a great rate and are full of carbon. Upon such leaves the larvae can develop rapidly. Except in the wettest jungles, as in Karwar and Assam, rapid growth is probably essential. Bean (1965): 620, observed that the period from egg to adult may be as short as 25 days; thus between July 21 and November 23 (the observed flight period) as many as six generations could be born while enough food was still in a condition favourable to growth.

In Khandalla the only foodplant observed was *Entada pursaetha* D.C., an impressively large creeper which at full growth reaches with massive contorted limbs right up into the forest canopy. The larva will not eat *Mezoneurum,* which is much commoner in the habitat than *Entada,* and also a leguminous species. A laying female was seen not to be interested in *Mezoneurum*; the individual mentioned in Bean (1959): 650-651 seems to have been trying to differentiate between these two plants which were tangled together.

It would be of great interest if someone could visit the Karwar jungles for this species, and try and find out what it lays on there, and check the extent of the flight period. At Khandalla there is a diapause from the end of November until July, but this may not occur in wetter places, or may be shorter. Khandalla is probably the westernmost edge of its range, where it seems to have adapted to drier conditions. One assumes that it is as a pupa that it lies over from late autumn until the monsoon is well established, but this has to be proved. It could be done if one had facilities for caging or sleeving larvae on growing *Entada* towards the end of the flight season. It would have to be in the jungle or near it, so that conditions as close to nature as possible were provided; and the worker would have to be ready for many disappointments and setbacks, including those from the destructiveness, curiosity or ignorance of human beings.


ASSAM
Southern Islands of JAPAN: between lat. 28° and 34°.
Western Ghats
Bombay
BURMA
TAIWAN
Wallace's Line
PHILIPPINES
Andamans
Sti Lanka
Nicobars
MALAYA
Sarawak
Sabah
Weber's Line
SUMATERA
Nias
GREATER SUNDAS
BORNEO
SULAWESI
MOLUCCAS
PAPUA
Bismarcks
Solomons
DJAWA
LESSER SUNDAS
Bali
Lombok
Torres Strait
Cape York
Queensland
Louisiades
Arnhemland
30°–35°S New South Wales
0
500
1000
1500
KILOMETRES
Wallace's Line
Weber's Line
To illustrate the Distribution of the Nacaduba complex
SHADED
Sunda Shelf - west of Wallace's Line.
Sahul Shelf - east of Weber's Line.
75
80
85
90
95
100
105
110
115
120
125
130
135
140
145
150
155
20
15
10
5
0
25

The Distribution of the *Nacaduba* complex.

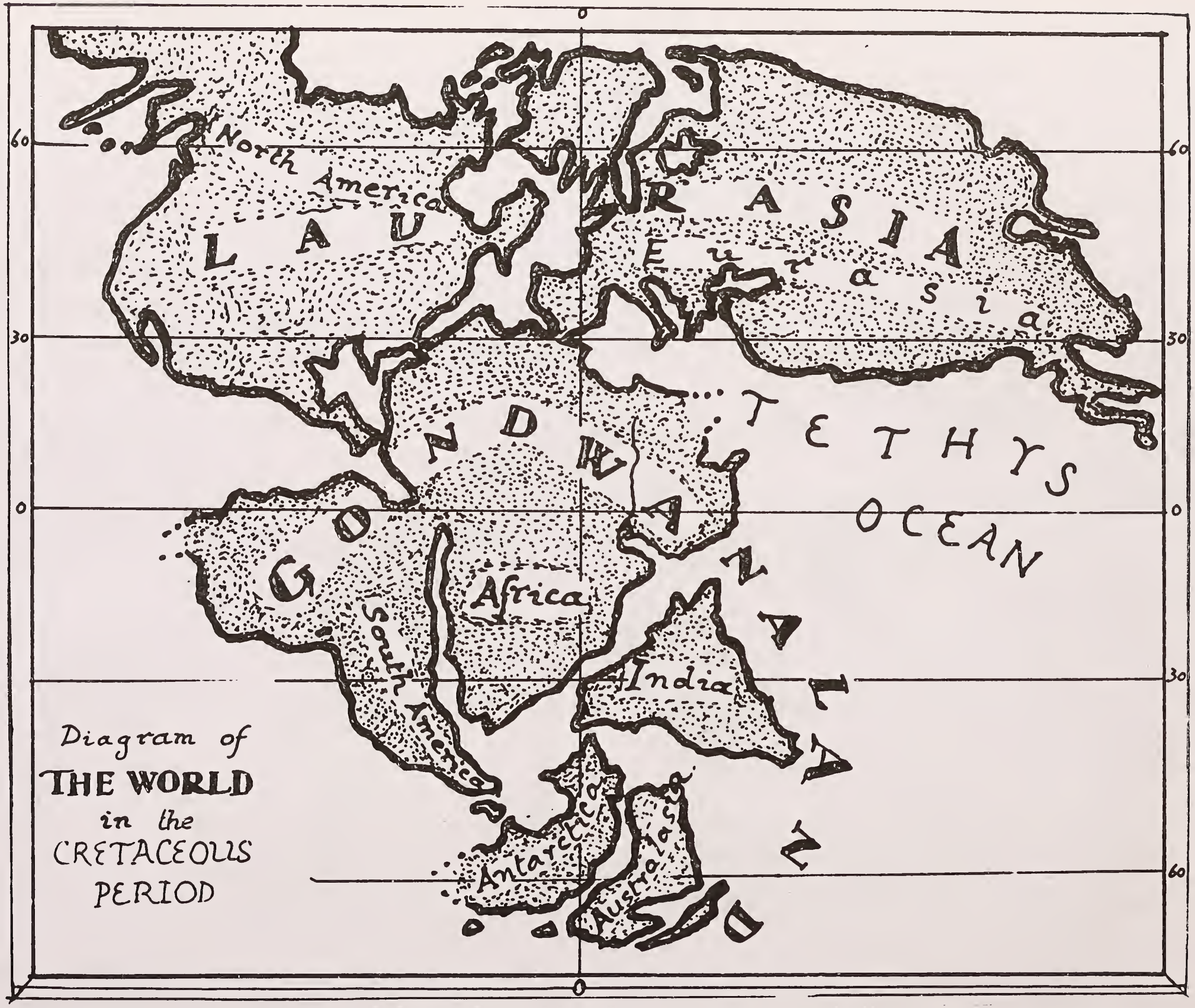
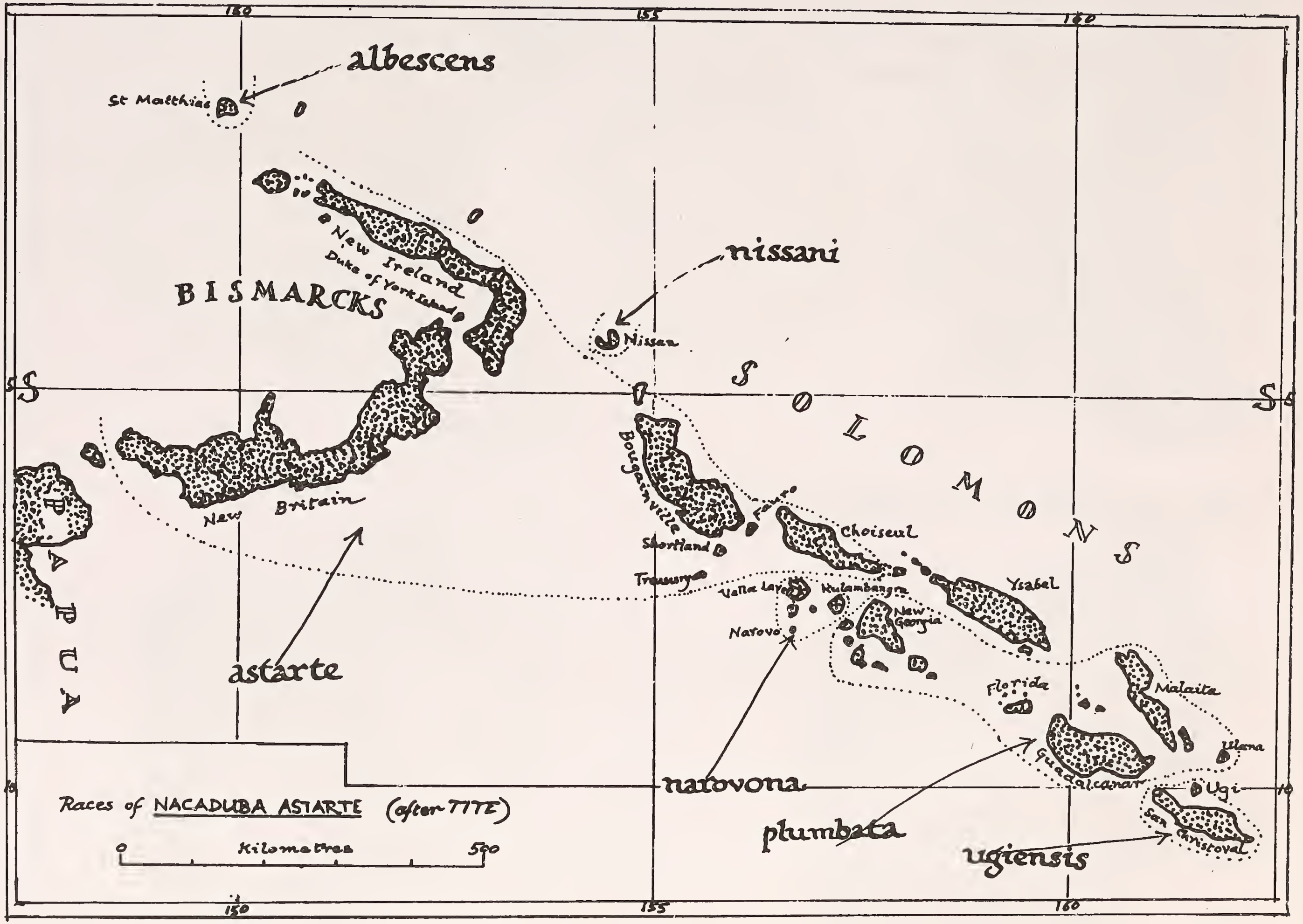


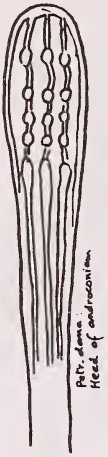
Diagram of
THE WORLD
in the
CRETACEOUS
PERIOD
LAURASIA
North America
Eurasia
GONDWANALAND
Africa
South America
India
Antarctica
Australasia
TETHYS
OCEAN
60
30
0
30
60
0

Diagram of the world in the cretaceous period. (Around 70 million years BP).

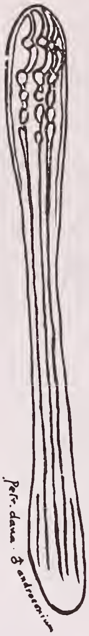

150
155
160
albescens
St Matthias
nissani
Nissan
New Ireland
Duke of York Island
BISMARCKS
S
SOLOMONS
S
New Britain
PAPUA
Bougainville
Shortland
Treasury
Choiseul
Ysabel
Vella Lavella
Kulambangra
New Georgia
Natovo
astarte
Florida
Malaita
Ulawa
Ugi
Guadalcanar
San Cristoval
natovona
plumbata
ugiensis
Races of NACADUBA ASTARTE (after TITE)
0
Kilometres
500
10
150
155
160
10

Races of *Nacaduba astarte* on island groups of the Sahul Shelf. (After Tite).

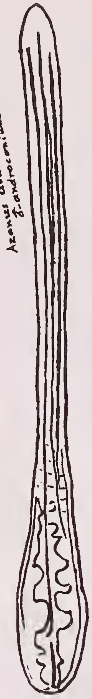
Bean: *Nacaduba* sp.


Petr. dana:
Head of androconium

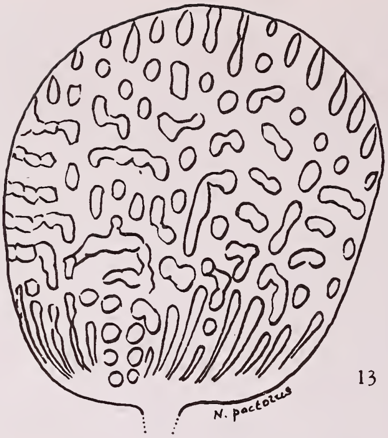
4


Petr. dana. ♂ androconium

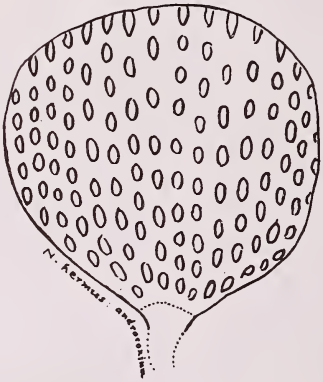
4(a)


Azanus ubaldus:
♂ androconium

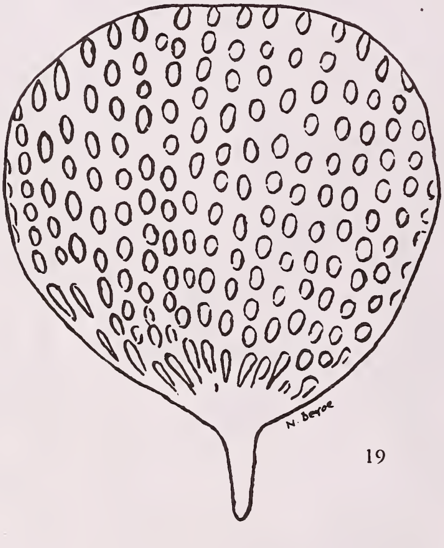
5



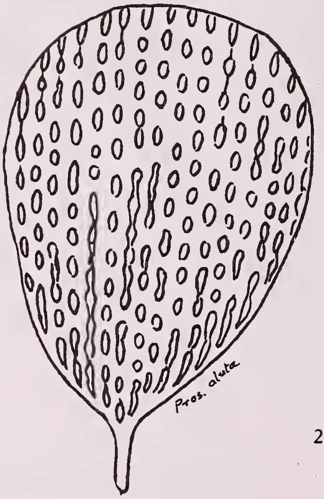
13


N. hermus: androconium

14



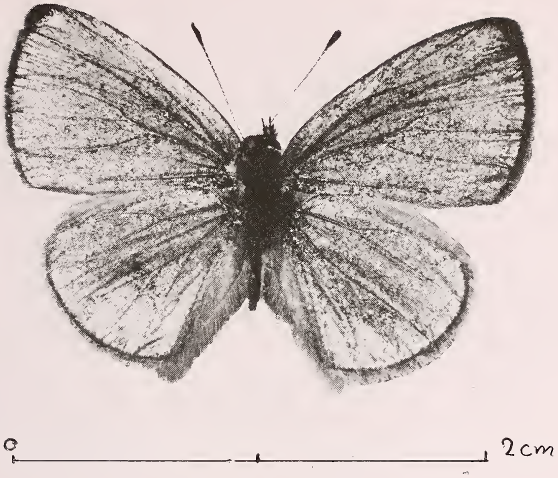
19

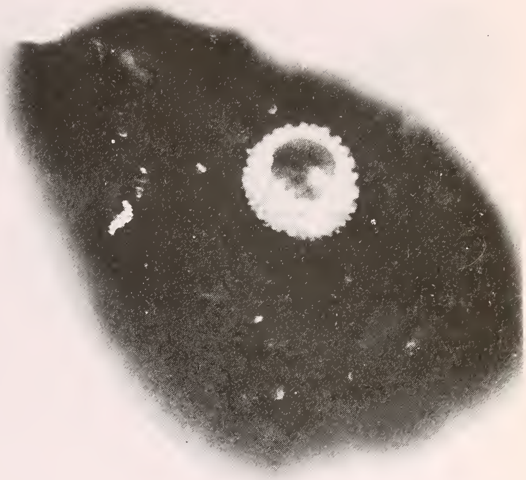


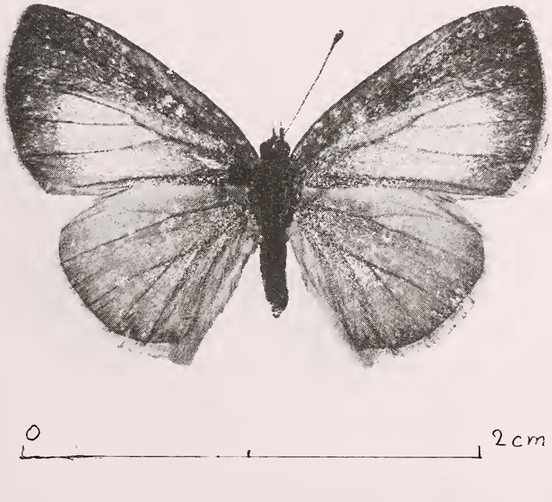
20

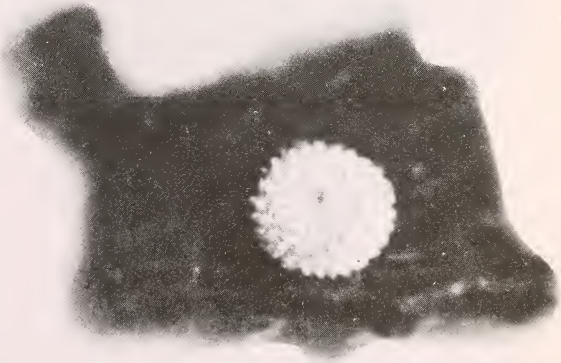
Androconia: 4. *Petrelaea dana*. 4a. *P. dana* (lower magnification). 5. *Azanus ubaldus*. 13. *Nacaduba pactolus*. 14. *N. hermus*. 19. *N. beroe*. 20. *Prosotas alutà*.

Bean: *Nacaduba* sp.





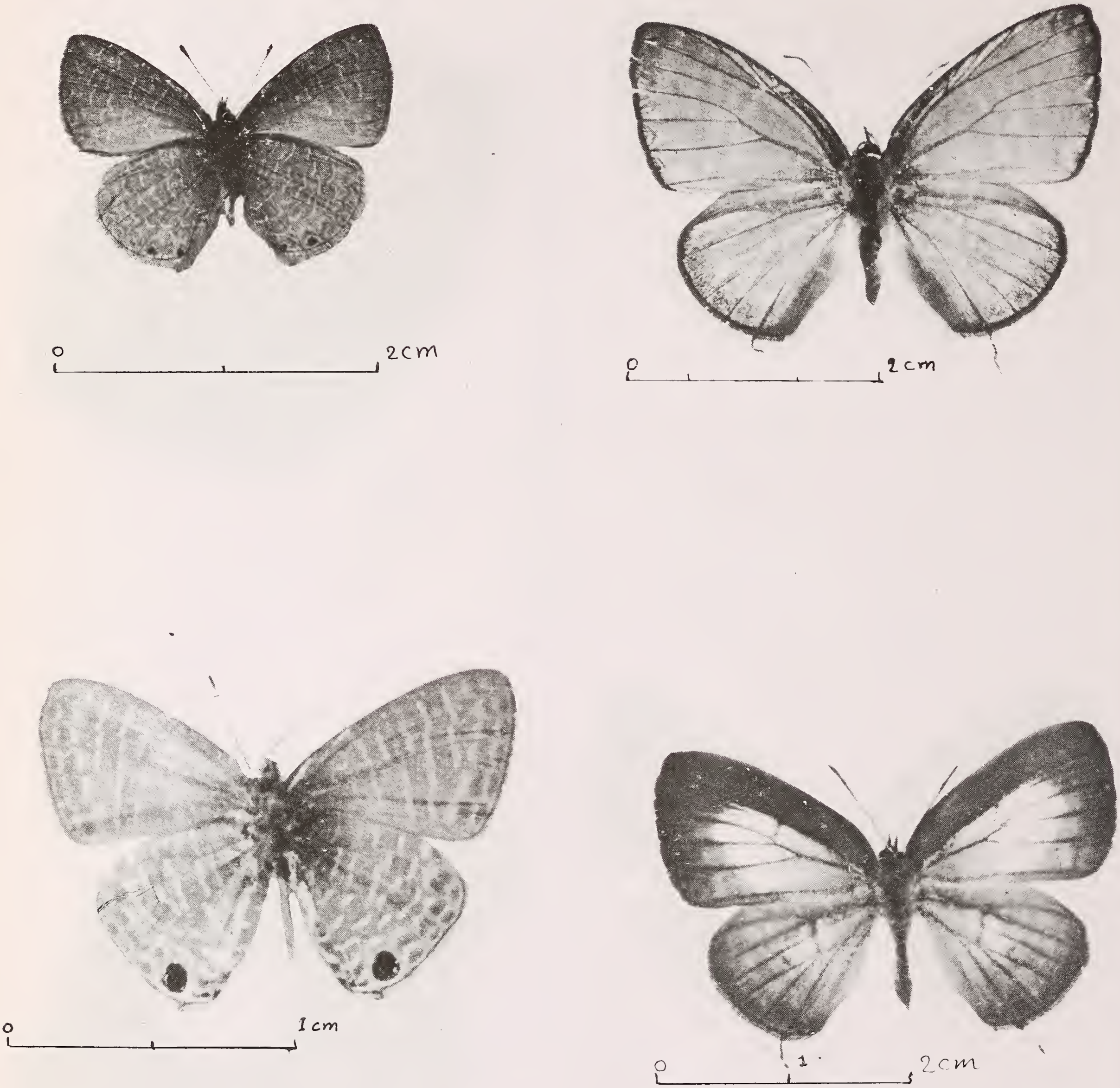




LEFT—*Petrelaea dana: Above:* male upperside, Western Ghats, October, 1961. *Below:* Female upperside, Manipur, September, 1957. (*Photos:* J. Woolmer)

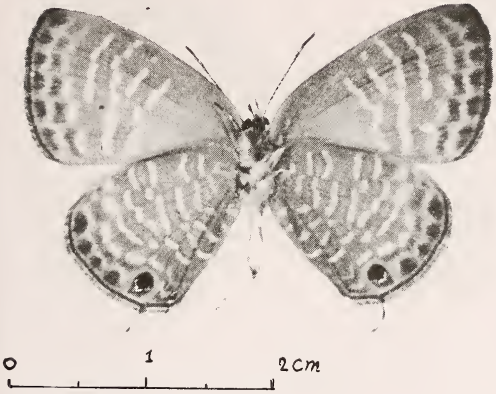
RIGHT—*Above:* Eggshell: *Nacaduba pactolus*. Western Ghats, November, 1971. *Below: Prosotus nora*. Mahabaleshwar, November, 1971.' (*Photos:* E.F. Bishop)

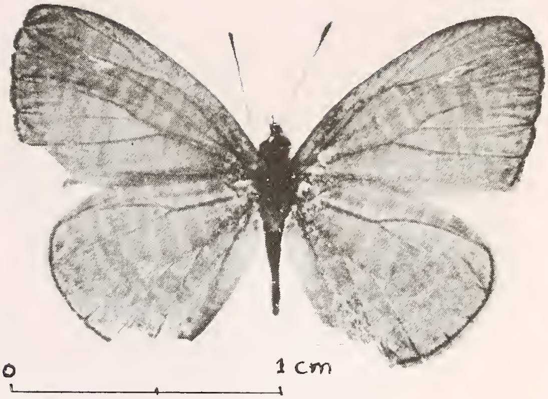
Bean: *Nacaduba* sp.

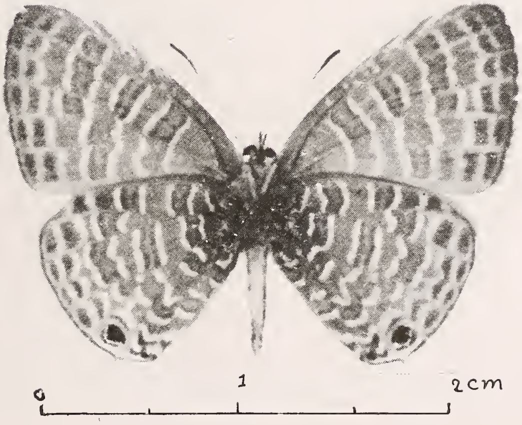


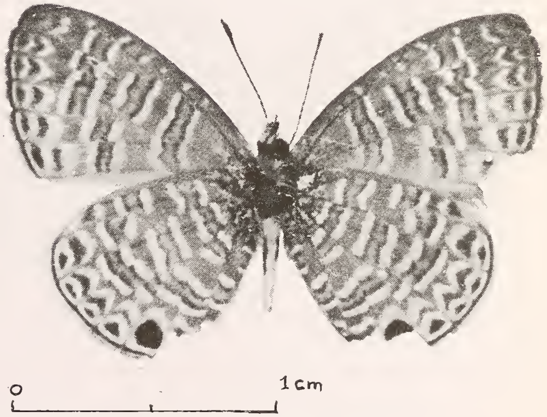
LEFT—*Above: Petrelaea dana*. Male underside. Western Ghats, October, 1961. *Below: Nacaduba beroe*. Male underside. Khasis, September, 1961.

RIHGT—*Above: Nacaduba pactolus*. Male upperside. Western Ghats, ex L. October, 1963. *Below:* Female upperside. Western Ghats, ex L. October, 1963. (*Photos:* J. Woolmer & E.F. Bishop)



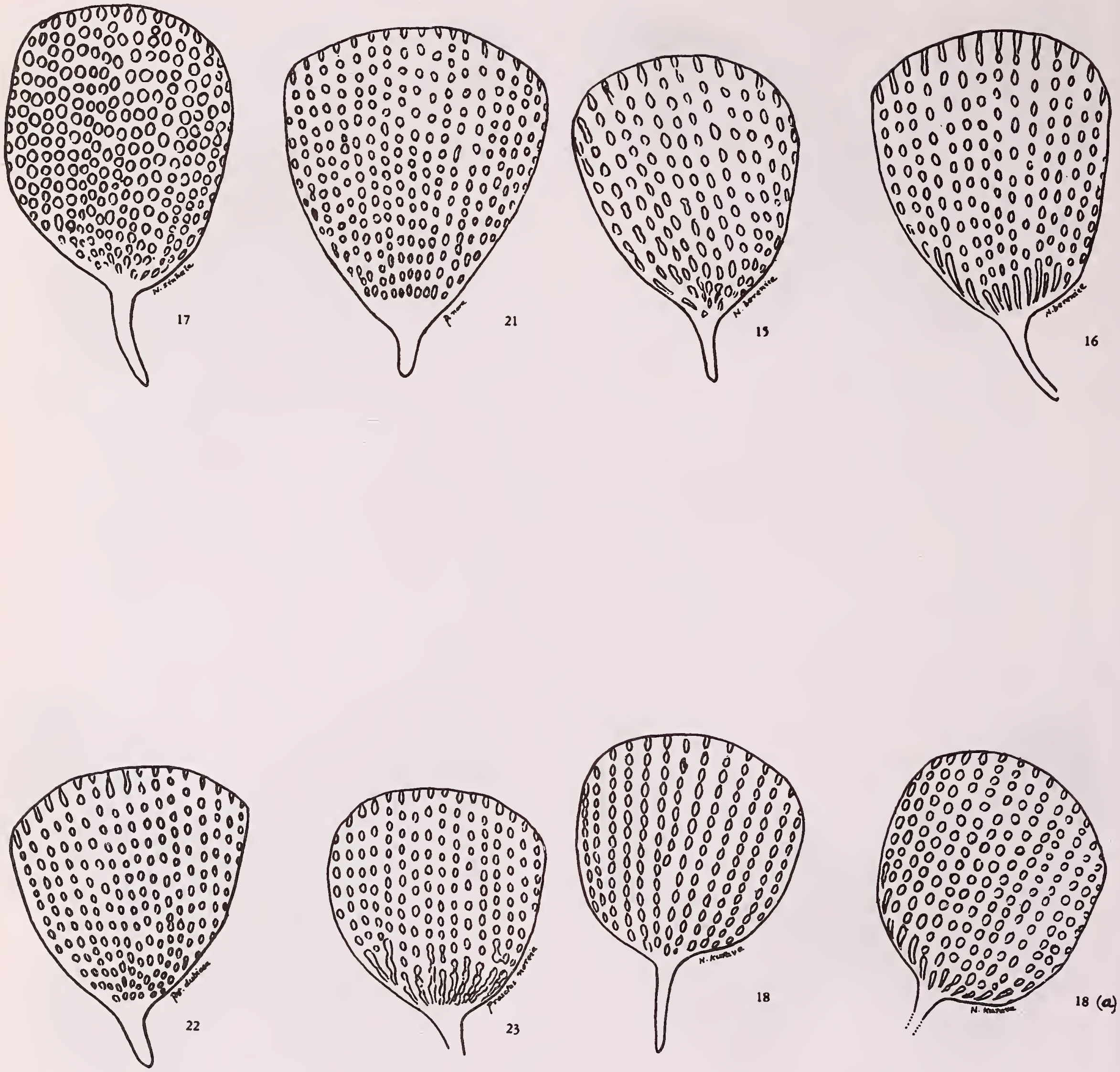






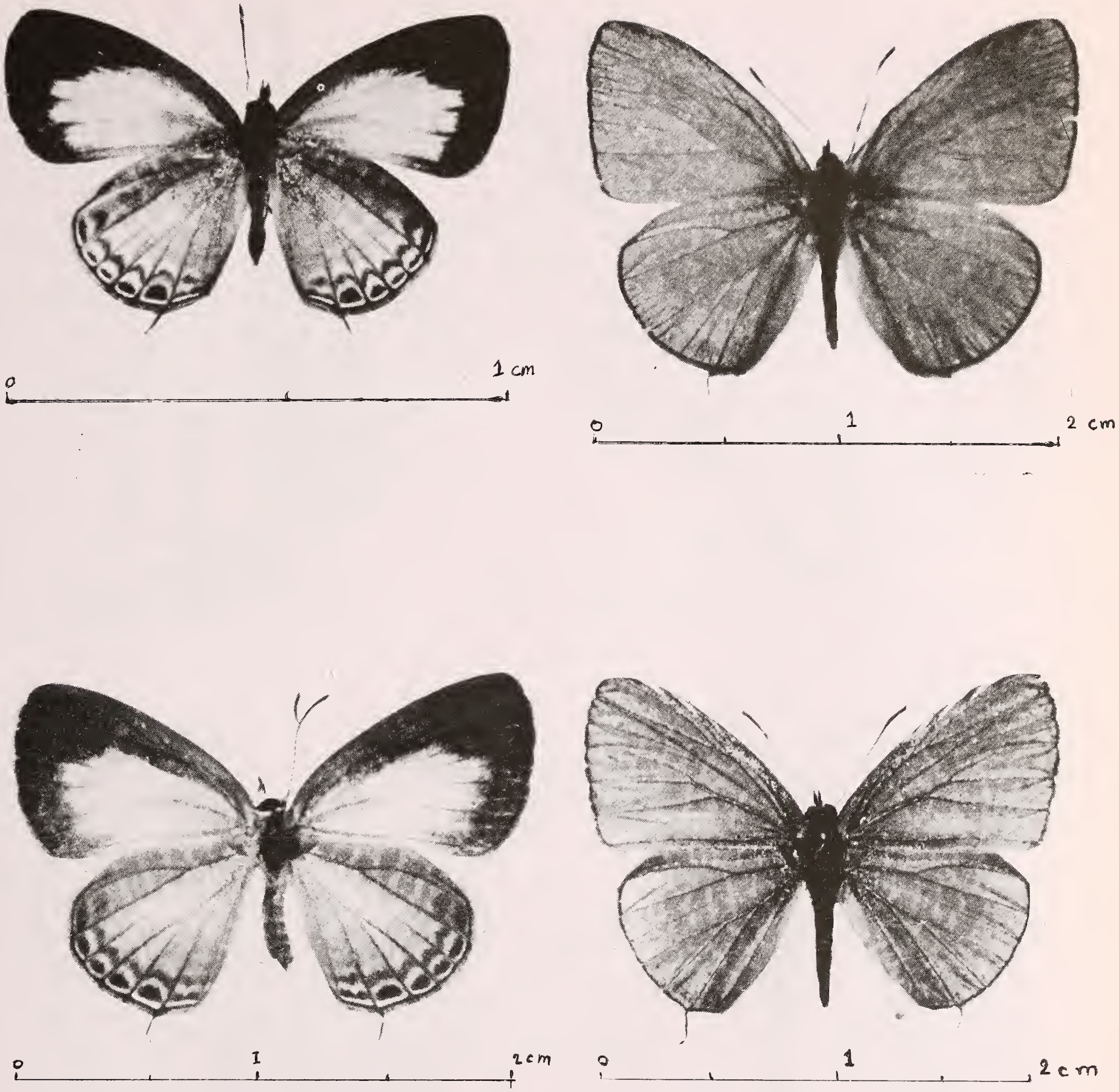
LEFT—*Above: Nacaduba pactolus.* Female underside. W. Ghats, ex L. October, 1963. *Below: Nacaduba kurava.* Male underside. W. Ghats, November, 1963.

RIGHT—*Above: Nacaduba sinhala.* Male upperside, Kandy, August, 1961. *Below:* Male underside. Kandy, August, 1961. (*Photos:* E.F. Bishop)


N. sinhala
17
P. nora
21
N. berenice
15
N. berenice
16
Pr. dubiosa
22
Prosotas noreia
23
N. kurava
18
N. kurava
18 (a)

1

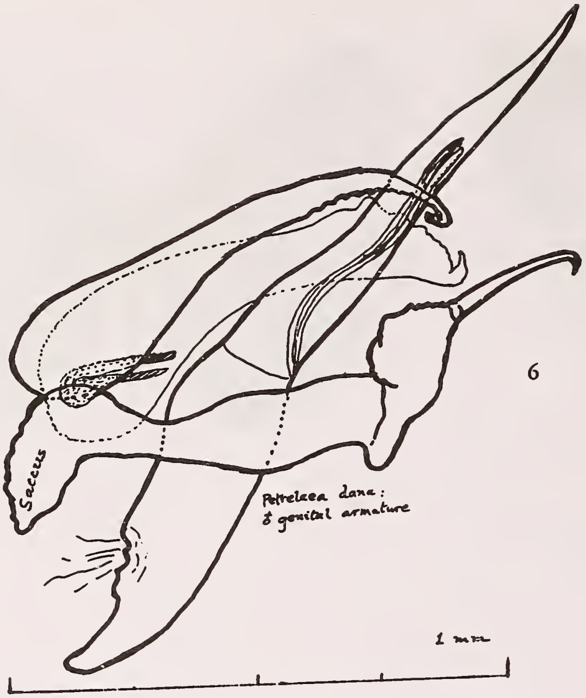
Androconia: 15 & 16. *Nacaduba berenice;* 17. *Nacaduba sinhala;* 18 & 18a. *Nacaduba kurava;* 21. *Prosotas nora;* 22. *Prosotas dubiosa;* 23. *Prosotas noreia.*



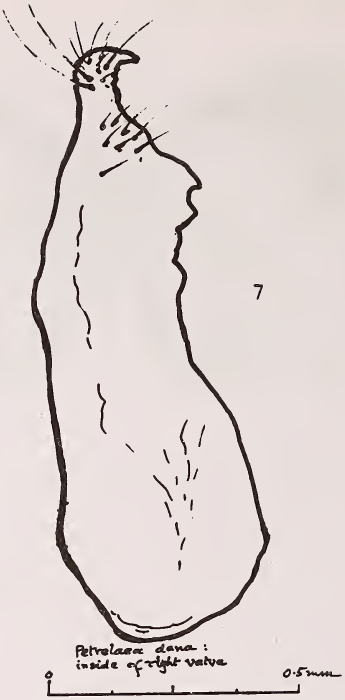
LEFT—*Above: Nacaduba sinhala.* Female upperside. Kandy, August, 1961. *Below: Nacaduba kurava.* Female upperside. Western Ghats, October, 1963.

RIGHT—*Above: Nacaduba berenice.* Male upperside. Matheran, February, 1967. *Below: Nacaduba kurava.* Male upperside. Western Ghats, November, 1963. (*Photos:* E.F. Bishop)

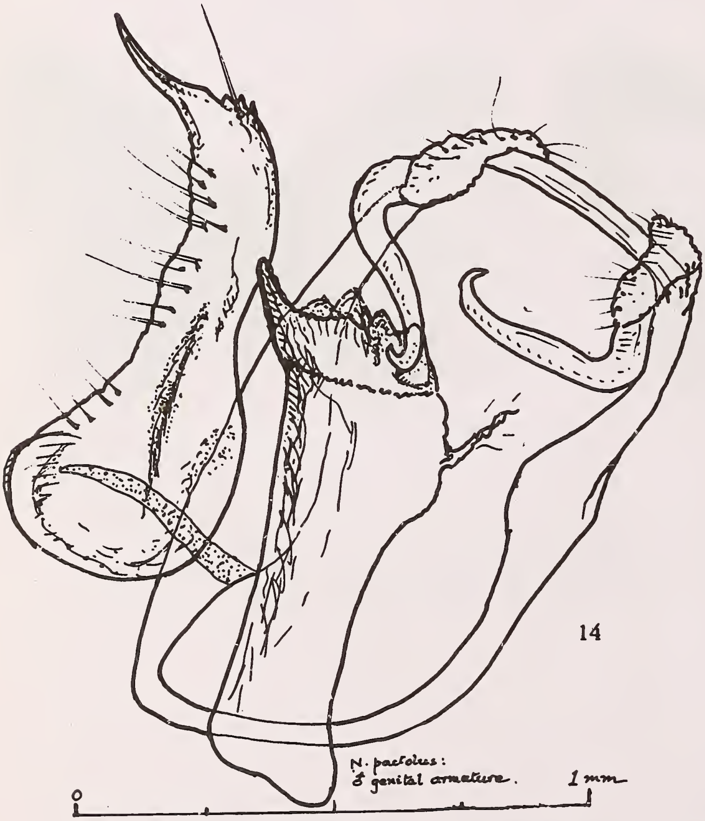
Bean: *Nacaduba* sp.


Saccus
Petrelaea dana : ♂ genital armature
1 mm

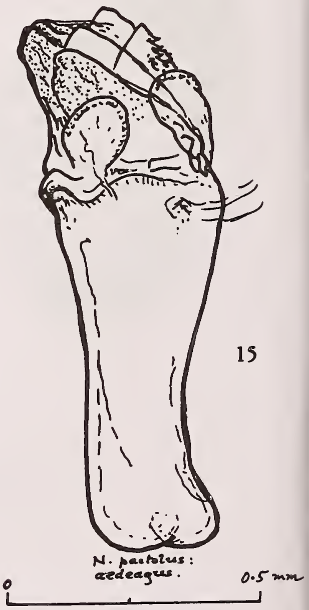
6


Petrelaea dana : inside of right valve
0
0·5 mm

7


N. pactolus : ♂ genital armature.
0
1 mm

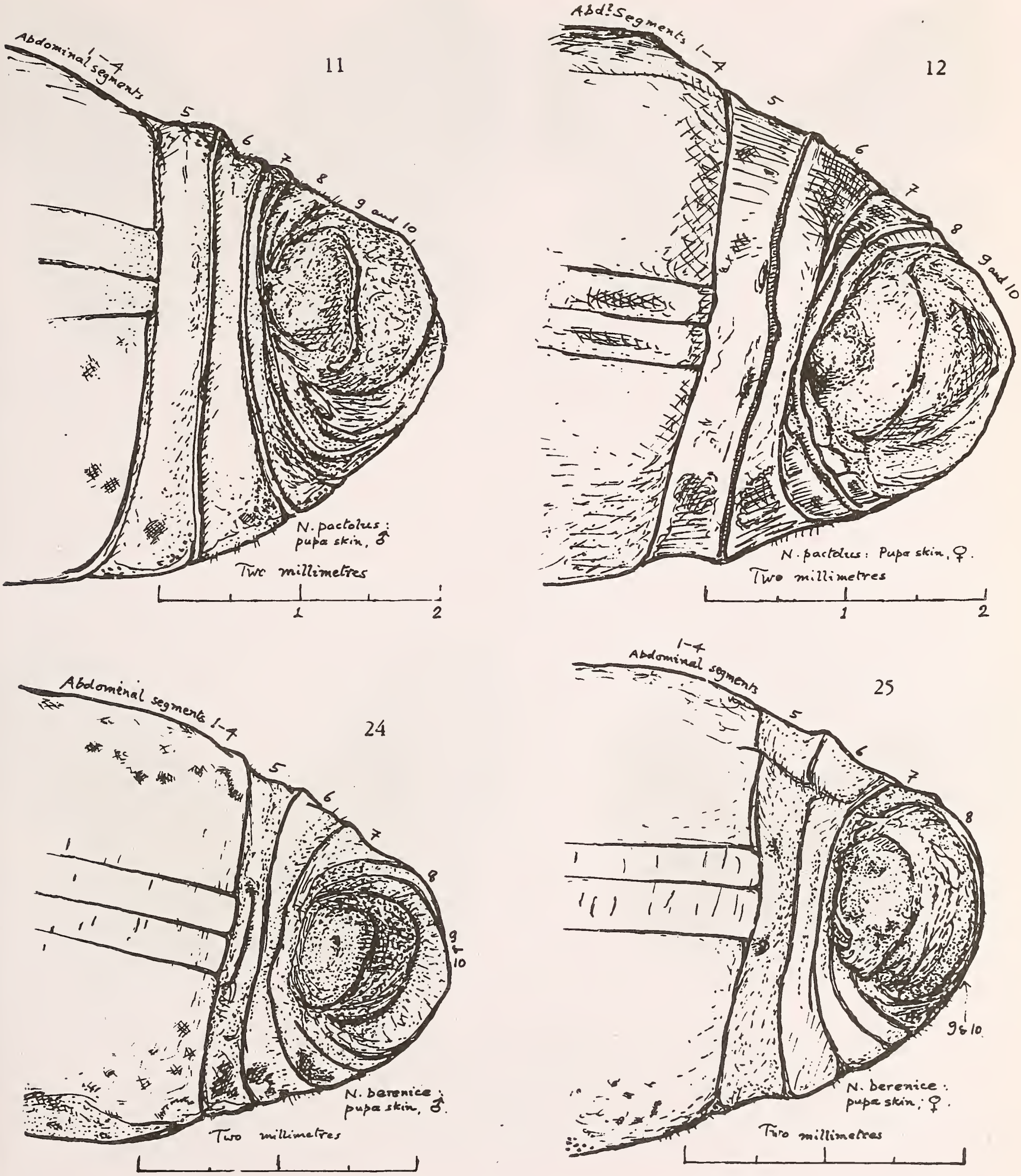
14


N. pactolus : aedeagus.
0
0·5 mm

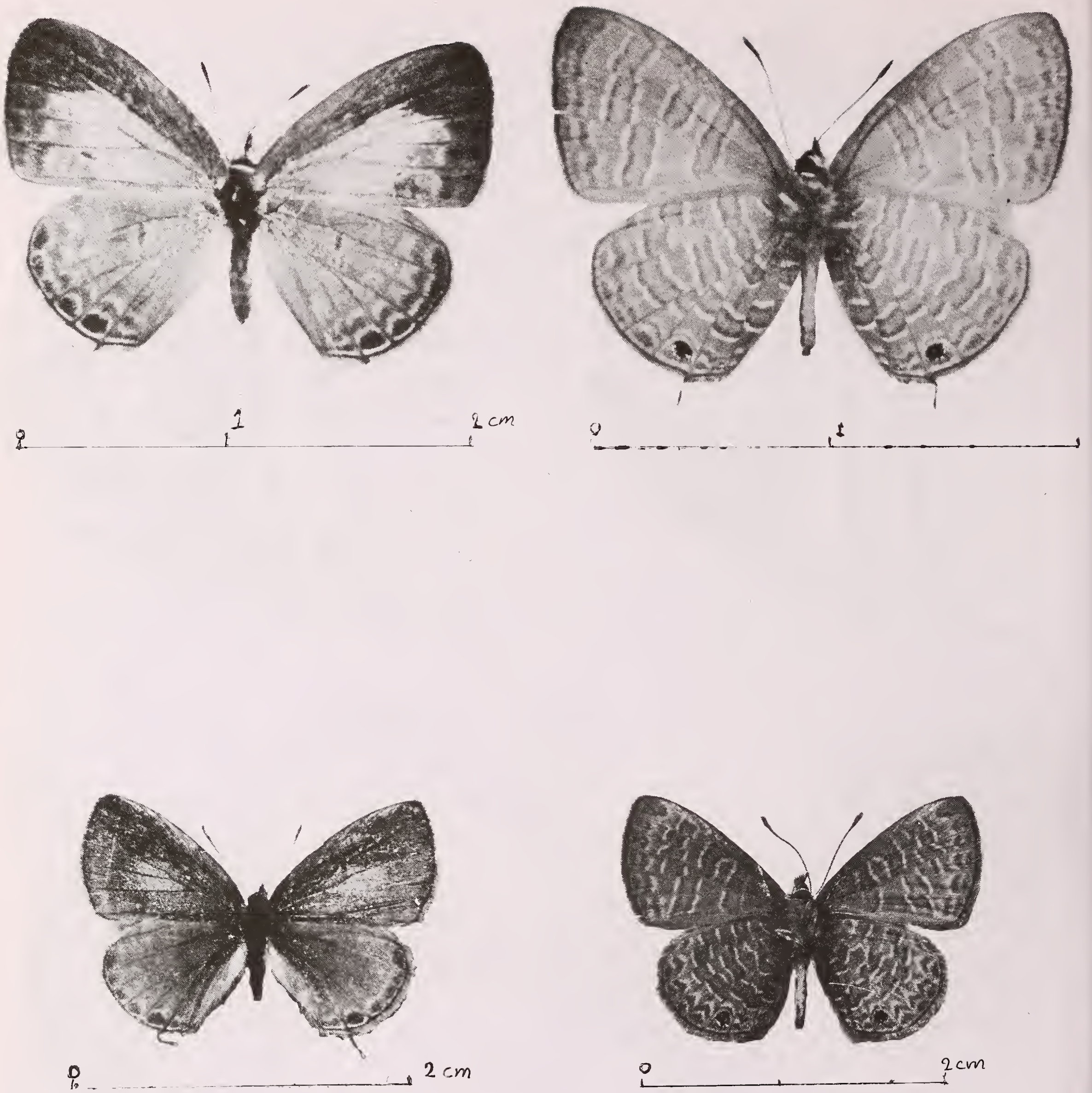
15

Genitalia: *Petrelaea dana*—6. Complete armature; 7. Inside of right valva. *Nacaduba pactolus*—14. Complete armature; 15. Aedeagus.

Bean: *Nacaduba* sp.

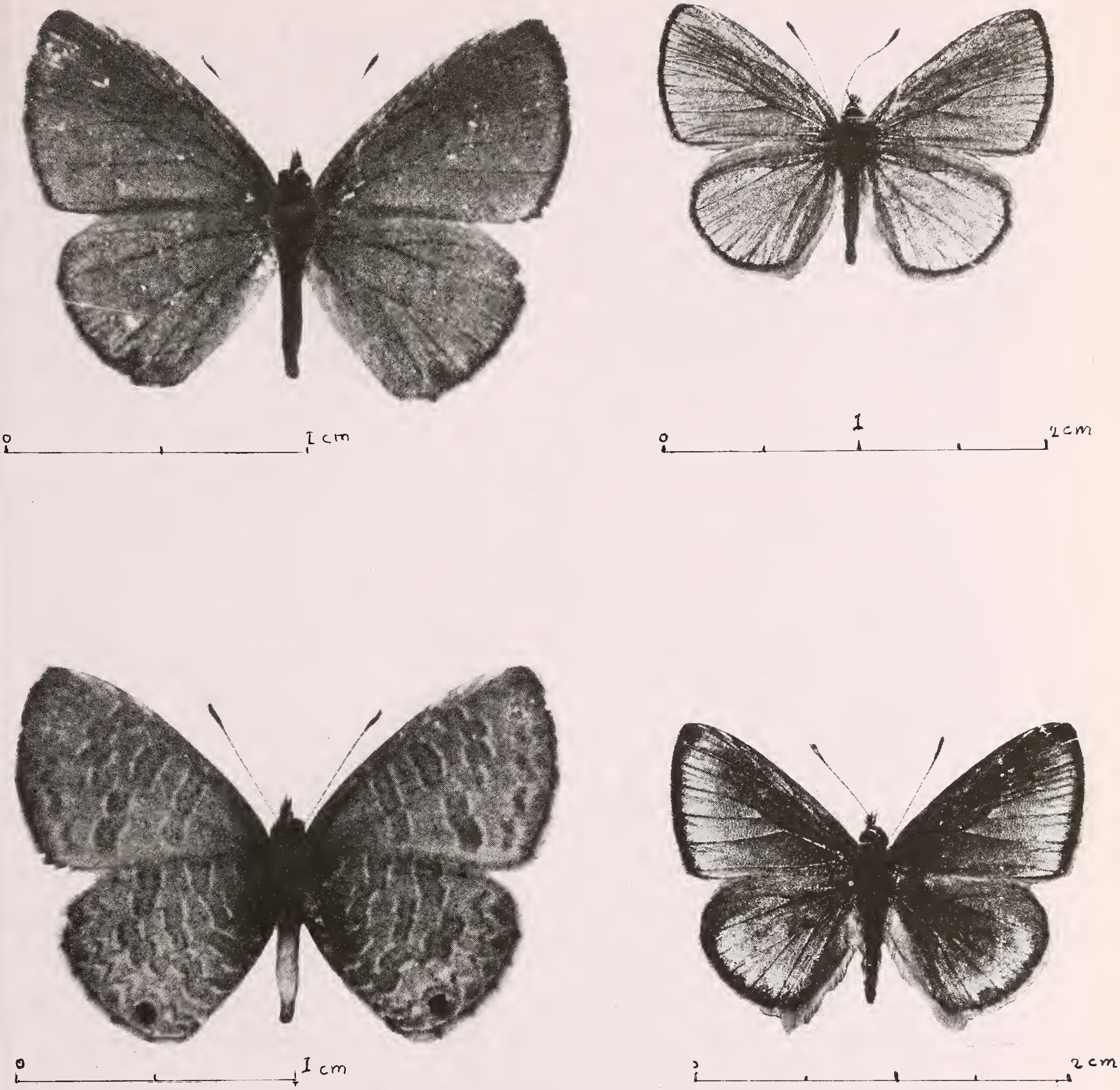

11
Abdominal segments 1–4
5
6
7
8
9 and 10
N. pactolus: pupa skin, ♂
Two millimetres
1
2
12
Abdl. Segments 1–4
5
6
7
8
9 and 10
N. pactolus: Pupa skin, ♀.
Two millimetres
1
2
24
Abdominal segments 1–4
5
6
7
8
9 & 10
N. berenice: pupa skin, ♂.
Two millimetres
25
1–4 Abdominal segments
5
6
7
8
9 & 10
N. berenice: pupa skin, ♀.
Two millimetres

Pupa skins: *Nacaduba pactolus*. 11. Male; 12. Female. *Nacaduba berenice*. 24. Male; 25. Female.



LEFT—*Above: Nacaduba berenice.* Female, upperside. Western Ghats, December, 1956. *Below: Prosotas nora.* Female, upperside. W. Ghats, November, 1971.

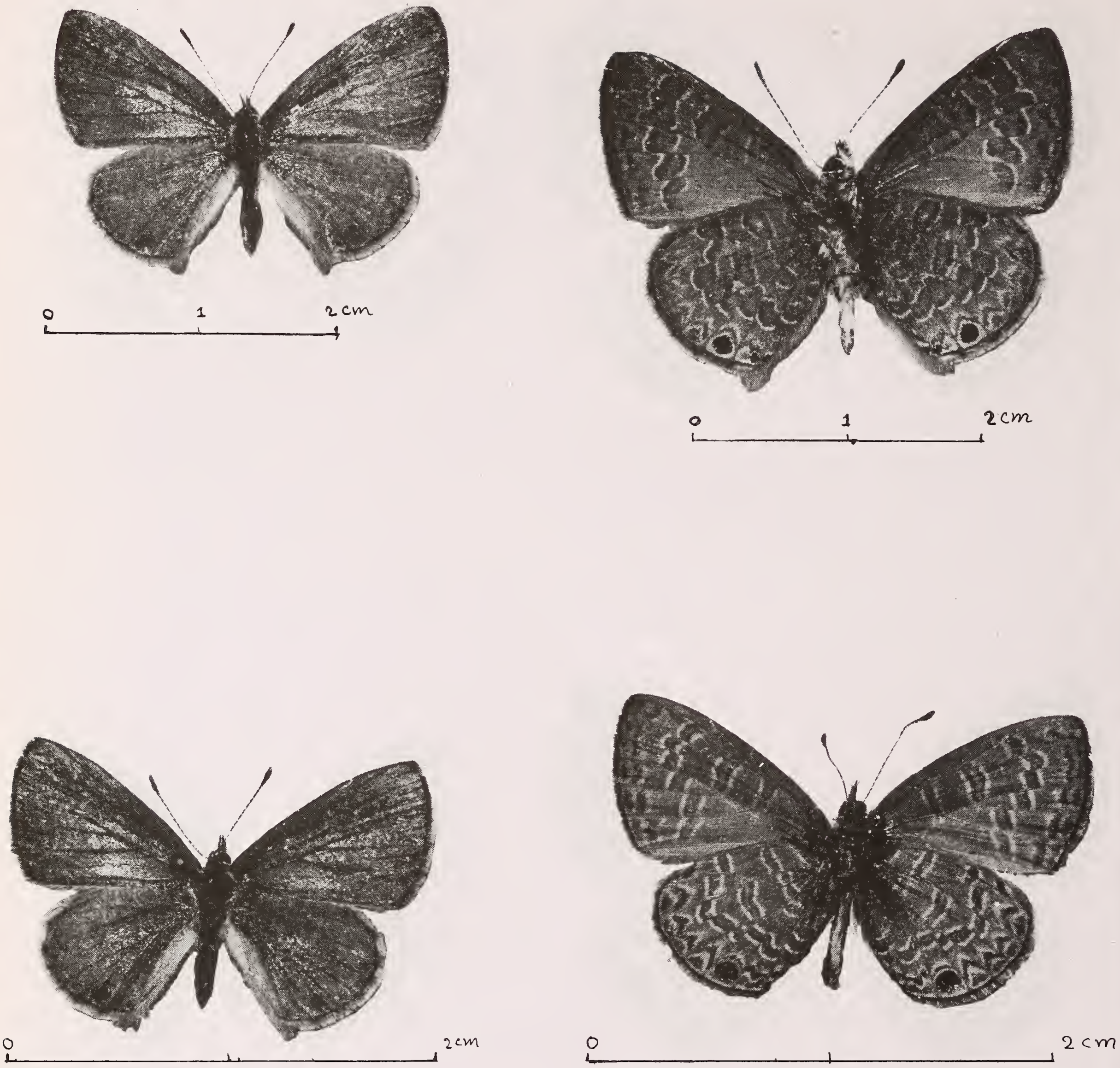
RIGHT—*Above: Nacaduba berenice.* Male, underside. Matheran, February, 1967. *Below: Prosotas dubiosa.* Male, underside. Western Ghats, November, 1971. (*Photos:* E.F. Bishop & J. Woolmer)



LEFT—*Above: Prosotas nora*. Male, upperside. Western Ghats, October, 1971. *Below:* Male, underside. W. Ghats, October, 1971. (*Photos:* E.F. Bishop)

RIGHT—*Above: Prosotas dubiosa*. Male, upperside. W. Ghats, November, 1971. *Below: Prosotas noreia hampsoni*. Male, upperside. W. Ghats, September, 1964. (*Photos:* J. Woolmer)

Bean: *Nacaduba* sp.

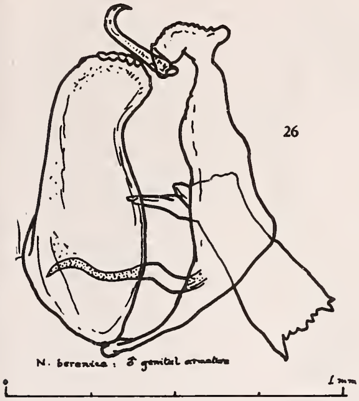


LEFT—*Above: Prosotas dubiosa.* Female, upperside. Western Ghats, November, 1961. *Below: Prosotas noreia.* Female, upperside. W. Ghats, May, 1961.

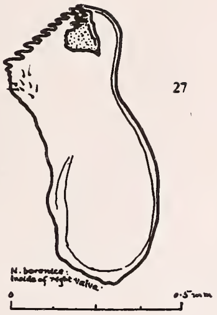
RIGHT—*Above: Prosotas noreia hampsoni.* Male, underside. W. Ghats, September, 1964. *Below: Prosotas noreia noreia.* Male, underside. Sri Lanka, August, 1961.

(*Photos:* J. Woolmer)

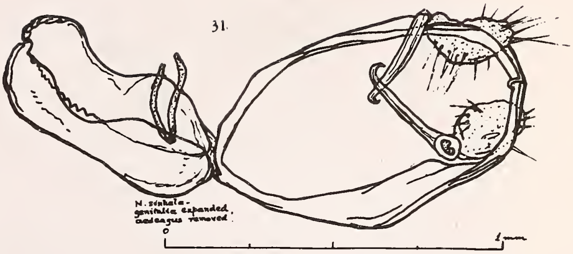
26


N. berenice : ♂ genital armature
0
1mm

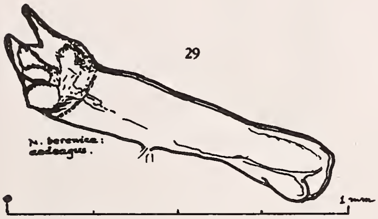
27


N. berenice: inside of right valve.
0
0.5mm

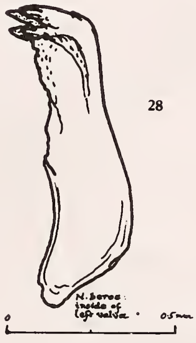
31


N. sinhala - genitalia expanded, aedeagus removed.
0
1mm

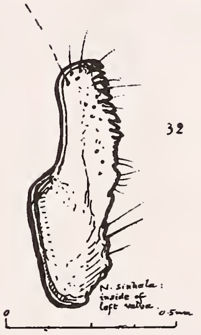
29


N. berenice: aedeagus.
1mm

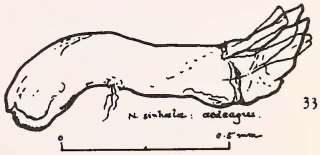
28


N. beroe: inside of left valva.
0
0.5mm

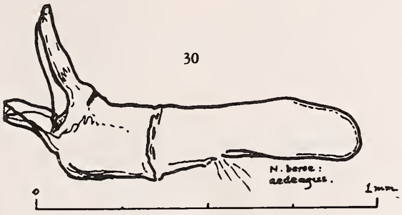
32


N. sinhala: inside of left valva.
0
0.5mm

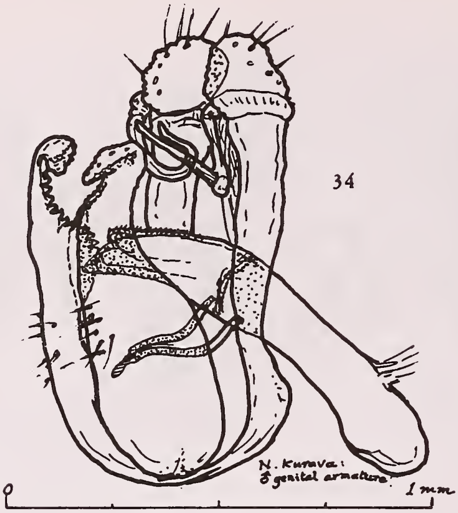
33


N. sinhala: aedeagus.
0
0.5mm

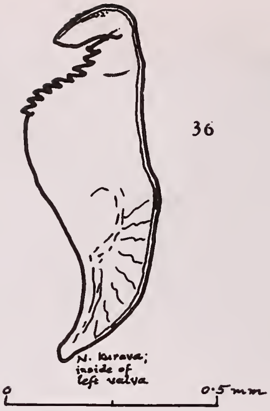
30


N. beroe: aedeagus.
0
1mm

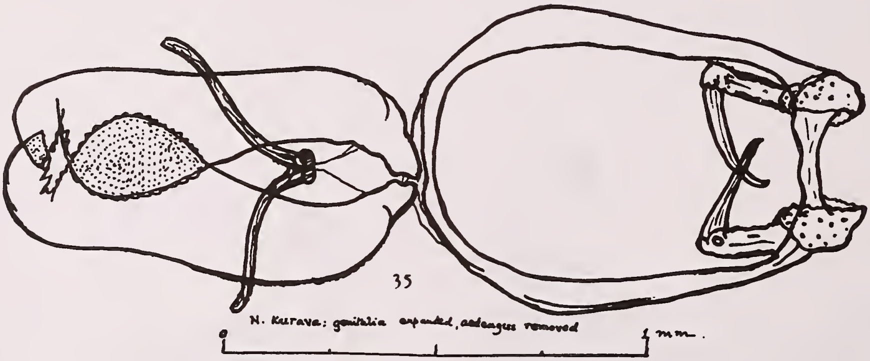
Genitalia: *Nacaduba berenice*. 26. Genital armature; 27. Inside of right valva; 29. Aedeagus. *Nacaduba beroe:* 28. Inside of left valva; 30. Aedeagus. *Nacaduba sinhala*. 31. Genitalia expanded, aedeagus removed; 32. Inside of left valva; 33. Aedeagus.


N. Kurava:
♂ genital armature
0
1 mm

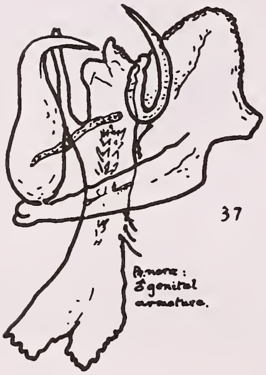
34


N. kurava;
inside of
left valva
0
0·5 mm

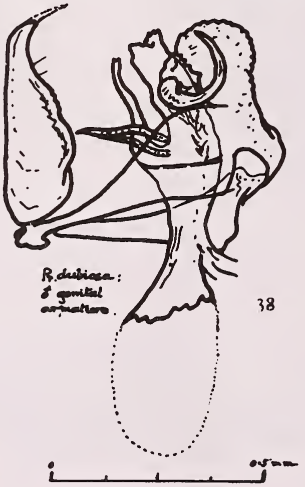
36


N. Kurava: genitalia expanded, aedeagus removed
0
1 mm.

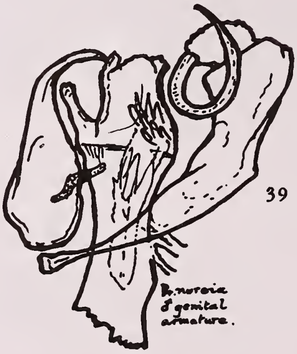
35


P. nora:
♂ genital
armature.

37


P. dubiosa:
♂ genital
armature.
0
0·5 mm

38


P. noreia
♂ genital
armature.

39

Genitalia: *Nacaduba kurava*. 34. Genital armature; 35. Same expanded, aedeagus removed; 36. Inside of left valva; 37. *Prosotas nora;* 38. *Prosotas dubiosa;* 38. *Prosotas noreia.*

An example of the difficulties facing a species at the edge of its range was observed during the poor and untimely rains of 1971. Dr. J. F. Lobo and I found a single eggshell after a long search. The larva had just hatched, but the terminal shoot of the *Entada* seedling, on which the egg had been laid, was withered and useless as food. At first we could see no larva. Then we saw the honey-yellow little creature on the still tender yellow lateral growths or tendrils. In the end we decided to take the larva for study; I am glad to say that it was not the last of its kind, for Dr Lobo observed adults in 1973, and my colleague Fr. Wain brought me three specimens taken in November, 1974. 1971 saw a disastrous monsoon. There was virtually no rain from July until some heavy showers, from 21-23 October, which merely freshened things. We found the larva on 12 November; nearby was a fifteen-foot *Entada* loose at the roots through erosion. There ought to have been dozens of *Entada* seedlings but we only found this one. So it is clear that the species can adapt to changing conditions, up to a point. Probably in those dry conditions it lays high in the forest canopy where one can usually see some young red leaves on the thick lianas.

One hopes that this Khandalla colony is still there, and that man has not utterly ruined the habitat.

The Egg.

The egg mentioned above, or rather the shell, tallies with an example in coll. from which an adult had been reared in 1963; I measured the diameter as 0.63 mm, and the height 0.20 mm. It is a very flat egg, not at all rounded when viewed laterally, and markedly different from that of *N. berenice,* a species present in the same jungle and also feeding on *Entada.* The egg-shell is shown on Plate V, and a comparison with *berenice* in fig. 2.

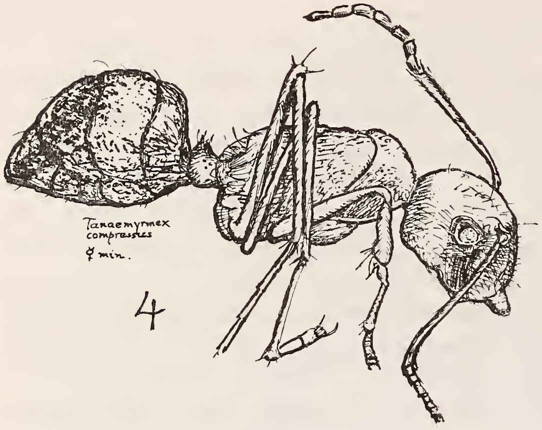
Ant Relationship.

The presence of ants with the larvae is intermittent, perhaps unusual; I must have looked at dozens of larvae of all ages in the field, and only once found ants attending them. Certainly ants seemed unimportant for the development and health of captive larvae. The one rule was to rear them on the tender leaves of a growing plant. However, it is quite possible that the larvae can call up ants if they want them, for two or three *Cremastogaster* ants somehow got into one of the cages from our garden or verandah in Pune. Unfortunately the note I made at the time was badly expressed, so that it may mean I put the ants there myself. All I can now say is that I do not think I did. The ants attended the nearly full grown larva in the cage and remained with it when put into another cage.

Two *Tanaemyrmex* (= *Camponotus*) ants were taken with larvae in the field. One was a light brown form which paid some attention to a larva in captivity; I did not see the larva respond with either its double or its single ant glands. The other ant was black. In the jungle it had been attending a larva possessively but was restless in confinement. When alive, this ant held the abdomen tucked below the thorax. Fig. 4 represents this ant, probably a ☿ min. of *Tanaemyrmex compressus* (Fab., 1787).

Notes on the Anatomy of the Egg-larva.

Figure 3 is from an egg-larva taken near Khandalla in September 1964. It was preserved in Pampel's fluid, stored after a few years in ordinary surgical spirit, then mounted direct in canada balsam. The 1971 larva mentioned above was not well preserved internally, as I forgot to use Pampel's. (Surgical spirit is, I suppose, better than nothing, but it makes material brittle. It should not be used for storage; it can reduce delicate genitalia to a slimy mess).



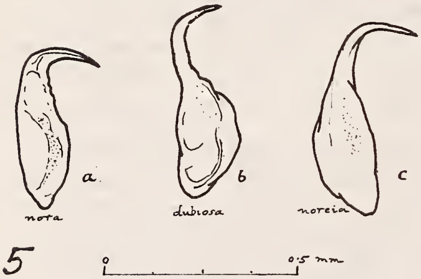


Fig. 4. Ant relationship: *Tanaemyrmex compressus* ☿ min. Fig. 5. *Prosotas* valvae: (a) *Pr. nora*; (b) *Pr. dubiosa*; (c) *Pr. noreia.*

Description of Mounted Egg-larva, Khandalla — IX-1964, S/N 2156:

The dorsal hairs are paired, as indeed in all young Lycaenid larvae; this is not shown in the diagrammatic figure given in Bean (1965): 615, fig. 1. It can be seen from the slide that these hairs are blunt tipped except for the pair immediately before the head. In most cases the hairs are slightly expanded towards the tip, and serrated on the forward side. There are lateral and ventrally directed hairs also, but for some reason they cannot be seen in the slide; they are clearly seen in the 1971 larva in spirit.

The chitinous rings which support the larval body are seen between the segments. The aorta can be made out as a vague line from behind the head to the end of the body; after the thoracic segments it is thicker and functions as the heart. The digestive tract, occupying the central cavity of the body, is clearly seen below the aorta. The ganglia of the nervous system are the darker bodies in the head and above the legs and claspers.

The Pupa

Plate XI: 11 & 12 show ventral views of the male and female pupae, drawn from skins, so that I am sure of their differentiation. The distinctions may be easier to discern in the living pupa, though then, of course it is not often possible to examine the creature properly. Talbot (1938): 8, gives as an important difference the production of the middle portion of segment 10 of the abdomen in female butterfly pupae. It reaches across segment 9 as far as the middle of segment 8. My drawing shows this more as a tendency to overlapping, especially when compared with that of the male pupa. Both drawings are as true to the originals as I can make them.

NOTES

1) For some information on the biology of the early stages see Bean (1965): 614-626.
2) Wherever *'Nacaduba beroe'* is mentioned in the 1965 Article read *'Nacaduba berenice'*. See also below, p. 39, note.
3) *Entada* seedlings may be easily transported during the rains, after they have sprouted and are still attached to the seed. Dry seeds may be encouraged to germinate by filing at the scar until the grey endosperm can be seen.

The Male Genitalia

Plate X: 14 was drawn from a partially successful attempt to expand the genitalia flat. I ought first to have removed the aedeagus. However, the result showed most of what is required, so I drew the figure as follows: The left valve, rather displaced, shows its inside with part of the furca near its base. The right valve is omitted for the sake of clarity. The

aedeagus remains roughly in its true position between valves and labides. The latter, with their falces, are also in their position, on the genital ring.

The valvae are shaped like the bill of a cormorant, and are characteristic of this species. This is useful under field conditions, when the genitalia of a worn four-line *Nacaduba* can be squeezed forward and seen with a hand lens to verify identity.

The terminal spike is directed ventrally. The inside of the valve is folded into a ridge from near the base to about half way up. This ridge is covered with tiny hooks or cornuti. Towards the tip of the valve ventrally there are rather shallow serrations, and three prominent teeth dorsally, near which a major bristle arises.

Aedeagus. The ductus enters dorsally, as in the whole *Nacaduba* section, and is clearly seen in the slide as a tube of light consistency, not of chitin. (Plate X: 14). The ductus usually only appears vaguely after preparation, as in Plate X: 15. The aedeagus in Plate X: 14 seems to be lying on its left side, more or less; the most prominent terminal process is the single lobed Chapman's process, and the other projections belong to the partially everted penis. Below the Chapman's process is the zone, a girdling ridge which helps steady the aedeagus. Plate X: 15 is a dorsal view of the organ. Proceeding from above the zonal ridge are two rounded, ventrally hollowed lobes which correspond in position to the two-horned appendage in *Petrelaea.* (See fig. 1). The slightly swollen, cloven base of the aedeagus I take to be the coecum; (Latin = 'blind'; here the closed or blind end of the organ).

The Labides or divided uncus characteristic of the Lycaenidae seem to be of normal pattern in this species. The falces are somewhat flattened dorso-ventrally.

Note on the Androconia of the Nacaduba *Complex.*

As stated above under *Petrelaea* (p. 17) these can only be properly studied with the aid of the scanning electron microscope. I can, therefore, only give highly provisional information, and that about only eleven species.

The scales are scattered among the ordinary cloaking scales on the upper sides of the forewings. Each is attached to the wing by a footstalk or pedicel. The scales studied, except *Petrelaea,* are shaped like a Burmese fan or a table-tennis bat. In Table 4 'fan' means the scale is longer than wide, and 'bat' that it is roughly as broad as long. Some scales are symmetrical (S) or assymetrical (A). The pedicels merge gradually into the body of the scale except in *pactolus* where the scale springs at right angles from the pedicel in a slightly excavate line.

III. **Nacaduba berenice plumbeomicans**
(Wood-Mason & de Niceville, 1880)
(Plates IX & XII)

This species extends from Sri Lanka through peninsular India eastward to the Solomons, Queensland and Northern Australia. The Indian race extends from the Western Ghats to Burma and the Andamans.

Identification.

Until recently I thought my Western Ghats material was of *N. beroe gythion* Fruh. Evans (1932): 243, and Evans & Cantlie (1962): 79 make it the only species from the Western Ghats with hairs or hair-like scales on the discs, so I jumped to the conclusion I had *beroe.* It was only when I came to look at the genitalia that I found the valves quite different from those of *beroe* figured by Tite (1963) 89, fig. 16. I had an opportunity of showing my slide to Mr. Tite who considered it to be of *berenice.* The Hope Collections material of

TABLE 4

SOME ANDROCONIA OF THE *Nacaduba* COMPLEX

Text-figure		Shape	Symmetrical or Assymetrical	No. of 'Ridges'
4/4a	*Petrelaea dana*	Rod-like, swollen at ends, distal end larger.	—	8–10; i.e. (4-5 each side)
13	*Nacaduba pactolus*	Bat; sides nearly parallel.	S	16
14	*N. hermus*	Bat; rounded sides.	A	15
15/16	*N. berenice*	Fan; converging sides.	A or S	14–15
17	*N. sinhala*	Fan, parallel sides	A	18
18/18a	*N. kurava*	Fan, rounded sides	S	14
19	*N. beroe*	Fan; rounded sides	A	14
20	*Prosotas aluta*	Fan; elongate like auk's egg	S	15
21	*P. nora*	Fan; curved, converging sides.	S	19
22	*P. dubiosa*	Fan, as in *nora*, smaller, converging sides angled in middle.	A	17
23	*P. noreia*	Bat; rounded sides	A	16

N. berenice plumbeomicans comes from Assam, the Eastern and Western Ghats right down to Cape Comorin, but there are no *N. beroe* specimens from peninsular India. *N. beroe* would seem to have its headquarters from Sikkim into Assam and Burma, meeting *N. berenice* only in the last two areas and in Sri Lanka.

After several examinations of genitalia I felt confident in assigning my Western Ghats material of this species to *N. berenice*. The experience has taught me not to make mere distribution a deciding factor. If I had referred to Bell's beautifully accurate description of '*Nacaduba plumbeomicans*', Bell (1918) 661-662, I might well have arrived at the correct identity without genitalia examination.

Table 5 shows that the two species can almost always be distinguished by facies in the male, even with worn examples; and that genitalia are an absolute check. See Plate VI for a male underside.

EARLY STAGES

Egg-laying.

On 4.xii.1957, between 13 and 14 hrs, I found females laying in a hot glade of climax jungle near Khandalla, Western Ghats, at about 650 metres altitude. The place was probably a woodcutters' clearing. The undergrowth formed a thick barrier at the end; and there the sun caught it during the hottest part of the day. The butterflies were being attracted to a point where some long trailers from *Entada* seedlings sprawled over the tangled growths of other plants.

It seems likely that on this site a great number of eggs were being laid on a few

TABLE 5

DETERMINATION OF TWO *Nacaduba* SPECIES

N. berenice	*N. beroe*
Above:	Above:
1) Violet blue, frosted appearance.	1) Dark violet blue.
2) May be slightly transparent on hind wing.	2) Always quite opaque.
3) Discs of wings bearing hairlike scales, but sparsely even in fresh specimens.	3) Discs covered with white hairlike scales, abundant even in a rubbed specimen.
4) Apex of forewing rounded.	4) Apex of forewing produced.
5) Termen of forewing convex.	5) Termen of forewing straight in middle.
Below:	Below:
Catenulated bands shaded between the strigae, as in *Prosotas nora,* though the ground colour is not darkened.	Catenulated bands not shaded between the strigae, as in *N. kurava.*
Genitalia	*Genitalia*
Valva-broad; almost square serrated end, the ventral side of which is curled.	Valva-narrow; not serrated at end, but there are beaklike processes at the tip.
Aedeagus — The double Chapman's process is shorter.	Aedeagus — The double Chapman's process is longer.

plants in a small area. I have never seen the butterflies laying except on young tender red leaves. The great lianas of *Entada* do not produce many of these, especially in December, when the ground is drying up, and for the same reason there are fewer tender leaves on the seedlings which have survived after the rains. Consequently the *berenice* larvae may be reduced in numbers through starvation and cannibalism. They are well protected by colour and habits, but predators must find them more easily when they are crowded. And they must often be crowded, since both female and larvae require tender leaves only, and such leaves often occur where the sun does not warm them sufficiently to encourage egglaying.

On two sprays of *Entada* bearing young red leaves there were about sixteen eggshells, seven to ten young larvae about 1.5 mm long, and one larva of 2.5 mm. They were on leaves and stalks, all looking very like the bracts of the plant. The observer's confusion is increased because the axils of the compound leaves of *Entada* have a dark base, so that the axil looks like some kind of larva with a dark head. Near one of these axils was an empty eggshell and just beside it a newly emerged larva; soon it would begin the long upward climb to its first leaf meal. Judging by many eggshells seen in the field it seems that the emerging larva only eats a little of the shell — enough to get out, or a little more.

Egg.

According to a Ms note of 1957 the ground colour of a newly laid egg is yellow, but the general effect is whitish, because of the colour of the surface sculpture. Bell (1918): 662, must be credited with first pointing this out. It was noticeable when comparing this egg with that of *N. pactolus* which I found in the same locality, and often at the same time. The differences of sculpture are shown diagramatically in figure 2, drawn from sketches of eggs or eggshells collected in the Khandalla locality between 1957 and 1962. Unfortunately I cannot illustrate the whole egg, having lost my only specimen, and sketches made at the time are inadequate. But I have confidence in saying that the egg of *berenice* is covered with smaller and more numerous rounded knobs than the lumpy projections on that of *pactolus.* To the eye, a *berenice* egg looks prickly, a *pactolus* egg slabby. It is also a smaller egg; Bell (loc. cit.), gives 0.52 mm across and 0.25 mm high. On the other hand it is rounded in section, unlike the larger but quite flat *pactolus* egg which is only 0.20 mm high.

Bell (loc. cit.), gives a detailed description from which one could identify this egg without an illustration. I quote the following, in which he says that the complicated pattern of the sculptured walls or ridges radiate 'outwards in' slowly diverging curves like a catherine-wheel firework ... and 'there are sixteen such lines round the whole egg.'

In the centre of the top surface of the egg is the micropyle, surrounded by an area without high sculpture. Micropyle means 'little gate' (Greek), the minute hole through which a spermatazoon, released by the female as each egg is laid, finds its way in; I take it that a function of the converging ridges is to assist the process. The ridges can equally be described as diverging; they may well have the function of keeping the surface of the egg free from micro-organisms and discouraging such things from entering the micropyle.

Larva.

The young larvae observed in December, 1957 were ochre yellow with little indication of dorsal and lateral stripes. In one case the colour was reddish and the stripes rather more apparent. They sought their food eagerly and persistently; I saw one raising its head as if sniffing the wind while seeking for tender leaves; probably it actually was using its sense of smell. When disturbed the larvae dropped by a thread. After their first skin they were about 2.50 mm long. The ground colour was then brownish yellow, pinkish on either side of the now apparent dorsal stripe and between subdorsal and lateral stripes. These stripes were never sharply defined, even in the later stages.

In captivity there was cannibalism as the larvae grew bigger. Some died during the moult, probably from condensation. This always occurs in airtight containers. When a larva has laid itself up in order to change its skin, and so must not be disturbed, it is impossible to mop up all moisture around and beneath it. With the airtight method of rearing I only had five larvae left on 7 December out of the dozen or more collected on 3 December. I was obliged to keep them in this unsatisfactory way as the food plant had to be brought from the Ghats and kept in Pune. It did not do well in water, so I sealed the stalks and kept the supply in airtight containers, which worked better. But 'Nacadubas' should never be reared this way if it can possibly be done on growing plants. When I came to the problem of rearing *N. pactolus* I found it unsatisfactory even to provide fresh food daily from growing plants; the larvae only did well on growing plants and undisturbed. See Bean (1965): 619.

On 7 December the surviving *berenice* larvae were about 5 mm long, and by 10 December one was 10 mm long and greenish between the stripes. I now noticed the eversible tower-shaped organs on the eighth abdominal segment by tickling with a small paintbrush. I put three or four ants from the Pune garden with the larvae. They settled down with them and I saw one tapping the rear and other parts of a feeding larva, the ants still cling on when the larva moved up the side of the cage. The ants were likely to have been *Solenopsis geminata* Fabr., 1804, but I failed to keep a specimen.

When the young red leaves were all gone, the larvae ate young leafstalks I crushed up. They would even eat the more tender parts of green leaves, making holes through, but leaving the lateral veins.

Larvae of 8 to 10 mm in length retained the power to drop by a thread when disturbed. When I tried to pick them up with a damp brush they often feigned death for a short time, crawling away soon afterwards.

Pupation.

From 13 to 15 December the five larvae prepared for pupation, each on the upper surface of a leaf. They placed a number of untidy threads near themselves, especially at the hind end, but the girdle, near the thorax, was hard to see. One larva died before pupating. The pupae were about 8 mm long and 2.50 mm across the thorax. In colour they were pinkish brown, darker on the head and wingcases, with a chain of dark brown dorsal blotches and lighter brown freckling elsewhere. Plate XI: 24 & 25, of the undersides of the abdomens of male and female pupa skins, show the outward differentiation between the sexes as in *N. pactolus* (Plate XI: 11 and 12).

Eclosion.

On 19 December one of the pupae seemed near emergence but had become loose from its girdle. The back of the thorax had darkened, the eyes were seen as dark oval shapes, and there was a dark brown dagger-shaped mark at the apex of each wingcase. A deformed male came from this pupa on 21 December. The next day there were three perfect males. Thus only a quarter of the larvae came through, due to inadequate conditions in confinement. Unfortunately I did little further study of the early stages of this species, seemingly very like those of *N. pactolus* which, three years later, I reared from the same locality.

Adult.

Nacaduba berenice in the Western Ghats near Pune appears in the last week of July, during the rains, but continues until the end of February. This means it is able to develop well into the dry season. In contrast *N. pactolus* in the same Khandalla area was never seen in the dry season. The flight period of *berenice* is deduced from the data of 55 caught specimens taken in small numbers most years between 1952 and 1962. It is commonest from November onwards, varying in abundance from year to year. For instance, 1957-1958 was a good season for it in Khandalla, but I saw none after the poor rains of 1971. I suspect that it may not be absolutely confined to climax jungle, since I caught two females in our Pune garden, one in August, 1955 and the other the following August, both at flowers, probably *Ageratum*. Although these examples are likely to have been strays, the possibility of a *berenice* colony in the Pune city neighbourhood should not be ruled out. There could well be a plant it could eat in the Empress Gardens or the Kirkee Botanic Gardens, though I doubt if *Entada* is there. (It certainly prefers *Entada*, at least if it is available, for I saw a laying female inspect the young red leaves and tender shoots of the common *Mezoneurum* for quite some time, but then go off and lay on the rarer *Entada*. Bell (1918): 664, says it eats *'Wagatea spicata'*, but I think that is a former name for *Entada*. Certainly the insect is adaptable to some extent. In August, 1956 I took both sexes in bungalow compounds near Khandalla at the flowers of an *Impatiens,* and a little way off found a single stand of *Entada* in a grassy lane rarely frequented by men. The growth was destroyed later, and I saw no more *berenice* there. It does seem that the species will persist in areas, once jungle, where a food plant has managed to hang on.

The only other locality where I encountered this butterfly was at Matheran, the 700 to 800 m. hill-station near Bombay. I took it at *Leea* flowers in February, 1953; in February, 1967 males were frequent at mud along the shore of Charlotte Lake, near the entry of a stream. Many were in perfect condition and must have emerged the same day. (Due to its habit of lurking among the undergrowth, this butterfly quickly becomes tattered and worn). In November, 1971, during a short visit to India, I took two females sitting on bushes near the Lake. Unless the food plant differs on Matheran, I would guess that the butterfly would be commonest somewhere southwest of Charlotte Lake, down the cliffs where there is *Entada,* for I do not remember seeing the creeper on the tableland of Matheran.

The Khandalla specimens were usually taken on leaves, once noted on the flowers of *Cylista.* In flight, *berenice* is not so jiggy and fast as its smaller allies *Prosotas,* the difficulty in catching them being the thick, bushy, usually prickly, places they live in. Almost invariably one must endure discomfort to get them.

There is no constant seasonal variation that I can see from a long series covering more than ten years. Certainly there is nothing like some *Jamides* species in the DSF, when the catenulated bands on the underside tend to get filled in. In *berenice* these bands may be sharp or obscure at all seasons, depending probably on the degree of dampness in the early stages, the quality of the food and the length of larval life. On the whole, females are more strongly marked below than males.

The male uppersides are dull purplish blue, sometimes verging to brown, the colour moderately lustrous at an angle in daylight. I have one of a darker and clearer purple, which gave me hopes of *beroe,* but the genitalia showed it to be *berenice.*

The shining blue in the female on the disc of the forewing may extend to the tornus, though normally a brown suffusion occupies this area. There is never white in the postmedian area of the blue patch; when the specimen is tilted, blue scales reaching to the apical angle of the brown margin can usually be made out. Females with such extended blue areas may look very much like *N. kurava,* and it may not be possible to be quite sure. Any female *Nacaduba* may be a puzzle to identify for certain.

The apex and termen of the forewing in both sexes is always well rounded, especially in the female.

I have found much variation in the size of caught specimens, apparently unrelated to the season of the year but dependent on local factors, as suggested above for variation in pattern. I have males with forewing 12 mm taken in January, and 15 mm taken in both February and September; females are down to 10 mm in February and up to 16 mm in August, but a female reared in January has forewing 12 mm, while a caught specimen of January another year is 10 mm. On the whole the males seem to come a little bigger than females, which seems in accordance with their life of play and search; the smaller, rounder wings of the females are suitable for life in the undergrowth, where the brilliant blue flash from their forewings signals their presence to the questing males. I have not noticed mating behaviour, which may indicate that it happens in retired places.

Note: Through my misidentification of this species in *JBNHS* 61: 3, 614 to 616, the words *'beroe gythion* Fruh.' on page 617 para. 1 should read *berenice plumbeomicans* WM & DeN, 1880, and similarly wherever else the word *beroe* occurs in the article.

The Male Genitalia.

The complete armature, (Plate XV: 26) is shown in a side view from the right of the abdomen, the valvae to the left of the drawing on the ventral side and the brachiae with the falces to the right, the dorsal side. The damaged aedeagus has slipped down from its proper position between the valves and the brachiae. The wavy organ low down between the valves is the damaged furca.

The Valva (Plate XV: 27). The right valva is shown from the inside, the ventral edge being to the right. The dotted area indicates the overhanging tip; it has about twelve minute teeth and three larger ones near the apex. The square end, or distal edge, of the valve has ten teeth, similar in size to the large teeth of the overhanging tip, and there is a group of spicules, or little bristles, near the dorsal side of the square end.

Aedeagus (Plat XV: 29). This is in side view, apex to the left and the dorsal side below. The zone is about a quarter along from the apex, as in the other species of the *Nacaduba* section studied here. The ductus enters dorsally, as throughout the section. I had to show the probable point of entry by sketchy lines. The short coecum is presumably the slightly swollen basal part of the organ. Near the apex springs the double Chapman's process, and the tips of the partly everted penis can also be made out.

For comparison, I have included Plate XV: 28, showing the valve of *beroe*, which is distinguishable at a glance from that of *berenice*; and Plate XV: 30, the aedeagus of *beroe*, in which the Chapman's process is about half as long again as that of *berenice.*

IV. **Nacaduba sinhala** Ormiston, 1924.
(Plates VII & IX)

On a short visit to Sri Lanka in August-September, 1961 I had my only experience of this small *Nacaduba.* The locality was a fine piece of forest, full of insects, near Trinity College, Kandy, at about 600 m. altitude. It is approached and partly skirted by a metalled road, but the rest of the circuit is a lane. There had been some heavy showers, and the leeches were out in force; as soon as I stood still they rushed up to me in their 'measuring worm' fashion. This jungle circuit used to be known as Lady Horton's Walk, and is mentioned by Evans as a good place for butterflies; Evans (1932): 33. The locality is on the data labels of this and other Lycaenids in the Hope Collection in Oxford, and one could wish that material was more often provided with such exact information.

The species has been considered a race of *N. berenice,* and on superficial characters this could be so. The males are much alike above. Below, the highly contrasting near-white bands in *sinhala* could have developed in an island population, as also the light colouring in the female. However, the distinctive genitalia, taken with the external differences, make it a good species, especially as Sri Lanka has its own race of *berenice* in any case, closely allied with *sinhala* though it would seem to be. Whatever may be the actual status of *sinhala* it is a form peculiar to Sri Lanka, and is not found in India; compare Woodhouse & Henry (1942): 89, para. 111.

N. sinhala is more variable in size than *berenice,* but on the whole smaller in both sexes. I only have six males and they measure between 11 and 14 mm (forewing); of these four were caught in the Kandy forest on the same day, and are all of different dimensions. Most of the males are larger than the females. The undersides are more strongly patterned than in *berenice*, and the postdiscal lunules are clearly zigzag. On the upper side the female is white on the disc of the forewing with only a little pale shining blue at the base. It is very like a small female *N. kurava.*

In the Kandy forest the butterflies were in fair numbers around bushes along the jungle lane. They have an erratic flight, but not as fast as the *Prosotas* species. The females were very slow and could be scooped up on the wing. The males were more difficult to catch. They sat alert on leaves in places where the sunlight, striking through the forest canopy, made pleasant stations for them. I did not notice whether they were pugnacious, but saw one being hustled off a good stand by an *Oriens* skipper, a species commoner along those bushes than *sinhala.* I saw a male solicit a female, which showed unwillingness by vibrating her wings.

My collecting had to be limited to three afternoon visits of under two hours, so I cannot say anything about the flight period or frequency of this species. I received one from Kandy (October) and another from Trincomalee (February).

Early Stages.

I do not think these have been described. Woodhouse & Henry (loc. cit.) refer to a detailed description by Bell (1918): 657, under '*Nacaduba atrata*'. This is an invalid name for *N. kurava.* From the description of the adult in the same passage there can be no doubt that Bell is describing the early stages of *kurava.*

The Male Genitalia.

Plate XV: 31 shows the armature expanded, the valvae to the left and the aedeagus removed. Between the two valves the furca is in position. The space between the labides is simply part of the genital ring, not extending into the abdomen as a saccus; this feature is typical of the *Nacaduba* section of the complex.

Valva.

See Plate XV: 32 for the inside of the left valva, which seems the chief distinctive part of the genitalia in this species. It has none of the hooded appearance of the *berenice* valve. In shape it looks like a human footprint. There is a toothed overhanging tip, but very much smaller than in *berenice* and difficult to show clearly in a drawing. There are about twelve, rather irregularly formed serrations on the dorsal edge, including those on the small overhanging tip. The rest of the dorsal edge is irregular rather than serrated.

Aedeagus.

See Plate XV: 33. This seems to me very like that of *berenice.* The tips of the penis are seen by transparency between the short double Chapman's process.

V. **Nacaduba kurava canaraica**
Toxopeus, 1927.
(Plates VII & IX)

Nacaduba kurava has a wide range and a number of races from the Western Ghats to Australia, Taiwan and Japan. Bell (1918): 657 gives a detailed description of all stages from his Kanara material. This would be the Indian form, which does not appear to be common in the Bombay-Pune area where I did most of my collecting.

In 1963, I took several males on the east side of a hill near Khandalla at about 800 m. Below me was a steep slope with trees growing out of it; the butterflies were perching on leaves, enjoying the hot sun and the updraught of warm air cooled by the foliage. From time to time they took flights on their own or in pursuit of one another. Two years earlier, I had seen similar behaviour in another jungle at about 650 m. In each case there was plenty of cover. I caught a female in the thick jungle, but never had the luck to come upon one egglaying. The only other female I ever caught came to *Ageratum* flowers in our Pune garden, far from any true jungle. I took a single male on an outlying part of the Ghats at about 1300 m., in a place where I often collected but had never found this species. All my males were taken between August and December from 1956 to 1964, but only in twos and threes a year except in 1963 when they were abundant.

From my meagre knowledge it seems that this is a wet-season and post-monsoon butterfly in the Khandalla area, and is not at all common there. Its sporadic appearance, with occasional abundance, needs an explanation. It may have migratory habits, but there is only a slight indication of this in the two strays mentioned above. The species is commoner farther south, as in Coorg and Kanara, and therefore may be at the edge of its range around Khandalla. Certainly it has migratory habits in Japan, where, again it is on the edge of its range. Kudrna (1974): 114-115 states that it is a migrant; in the warmest parts of Kiushu and Shikoku it only appears in the hot weather, but flies from March to November farther south in the Amami Islands.

The first specimen I saw alive was fluttering around a bush towards the end of the afternoon near the 800 m. site mentioned above, and the definitely purple colouring reminded me of *Anthene*, quite different from the dark, lavender-blue impression which *berenice* gives in flight. *N. kurava* is a strong, tough butterfly; in colour, swooping action, and sudden perching it is very like *Rapala manea*, which I encountered in the same jungles.

I know nothing about the early stages in Khandalla. Bell (op. cit.): 661, gives the foodplant in N. Kanara as *Embelia robusta* (Myrsinaceae), 'a large climber with ... longly' ovate leaves of a somewhat light olivaceous green with prominent 'purple veins, common in the moist forests of the Western Ghats'. He gives other foodplants as *Embelia ribes*, a climbing shrub, and *Ardisia humilis*, also Myrsinaceae, a tree. Wynter-Blyth (1957): 497 adds *Waltheria indica* (Sterculiaceae). From the botanical information available to me it appears that *Embelia* and *Ardisia* are not found in the Khandalla area, but that Sterculiaceae may be represented; Santapau (1957): 26, identified a tree species belonging to this Order, from Purandhar.

The Male Genitalia.

The complete armature is shown in Plate XVI: 34. The aedeagus has shifted from its proper position, roughly parallel to the long axis of the valves. The valves are on the left, with the furca between them, and the labides with their falces on the right. The dotted areas are meant to show parts visible by transparency. There are various hairs not depicted; they are present in all the forms studied here, but are not taxonomically important; see Eliot (1973): 391.

Plate XVI: 35 shows the genital ring with the valves spread to the left, the aedeagus removed and the labides to the right. That part of the genital ring between the labides is not deepened to form a saccus but is shallow, as in the rest of this *Nacaduba* section.

The *Aedeagus* (See Plate XVI: 34) is furnished with tiny spicules or spines in about sixteen rows on its dorsal side from the tip towards the zone. The ductus, shown by sketchy lines, is dorsad, as usual in this section. The Chapman's process is short. It appears to me as a single organ wrapped round the apices of the penis.

The Valva.

Plate XVI: 36 shows the inside of the left valva, the toothed edge facing across the genital ring. The whole valve is outwardly convex; see Plate XVI: 34 for an attempt to depict this. The serrations are strongly bent inwards. The apical head of the valve is armed for most of the way on both sides with very small serrations. The base of the valve is strengthened by its laminated structure there.

NOTES ON THE MALE GENITALIA OF *Prosotas nora, dubiosa* AND *noreia*

Tite (1963): 90 follows Toxopeus and includes under *Prosotas* Druce, 1891 'all those species having simple claspers terminating in a pointed hook, and an aedeagus with a truncate, branch-like process arising ventrally from just below the apex.' He says that we are dealing here with a natural group of related species; we should take into account not only the external differences from *Nacaduba* but also the general habit of life.

The small differences I have been able to see between the genitalia of the three *Prosotas* species studied are set out in Table 6, tentatively and for what they are worth. See Fig. 5 for the valvae and Plate XVI: 37-39 for the aedeagi.

VI. **Prosotas nora ardates** Moore, 1874.
(Plates XII & XIII)

This is a common butterfly over most of the area considered in this article. Between 1951 and 1974 I have taken or received it from sea level to 1300 metres, from the Ghats and the Deccan, from the Konkan and the Salsette Hills, and from compounds and gardens in the central of Bombay and Pune. During two short visits to Sri Lanka however, in August-September, 1952 and 1961, I took it only once, on the second occasion; it was a single male, at Haputale, 1200 m. in Uva State. On each visit the closely related *P. dubiosa* was numerous in Colombo. On looking at Woodhouse & Henry (1942): 91, para. 114, I found that my experience is similar to that of Moore in the last century; he saw *nora* only in ones and twos but *dubiosa* in 'clouds round the Madras thorn-trees in Colombo'. Since Woodhouse and Henry (op. cit.): 90, says it is a common butterfly in Sri Lanka the

TABLE 6

COMPARISON OF THE MALE GENITALIA OF THREE *Prosotas* SPECIES

	Nora	*Dubiosa*	*Noreia*
Valva:	length about 0.52 mm hook gradual from body of valva.	length about 0.52 mm hook very abrupt from body of valva.	length about 0.56 mm hook abrupt from body of valva.
Aedeagus:	Chapman's process *c.* 0.225 mm long. Featherlike features from below zone to just above base of Chapman's process.	Chapman's process *c.* 0.25 mm long. Such features above zone only.	Chapman's process *c.* 0.225 mm long. Such features extensive, above and below zone.
	Enlarged coecum probably present.	Enlarged coecum present.	Enlarged coecum probably present.

explanation may be that *nora* has intervals between its flight periods there. It seems to tail off in Western India in June and July; at least I have no records or material of that period.

On the Western Ghats near Khandalla, a typical spot for *nora* was visited several times in May, 1960. The males were basking and playing on the leaves of a sunlit tree in a glade between 10 and 14 hours on the western side of a small wood. Their intricate jigging flight, and their speed as they dashed after other males, made them hard to catch, and often they flew out of reach. They also had the annoying habit of taking a long while to settle, then shooting off at once. But eventually a chance would come of getting one with a well aimed upward sweep.

Both sexes come to flowers. In the glade at Khandalla I noted males at *Leea* as late as 17 hrs. Females were around *Albizzia*, probably for egglaying as well as drinking, from 10 to 14 hrs. At another 'playground' on the Khandalla hillsides a male was seen hustling off a *Caleta decidia*. In Bombay city I saw either *P. nora* or *P. dubiosa* laying on some Mimosa-type bushes in flower which I had grown six or seven years before in the Mazagon compound for the benefit of such butterflies. In September, 1960 I took *nora* in the Old Cemetery at Colaba around the ball-like flowers of *Leucaena*; and in November, 1971 a female at Colaba Point. The species was frequent in our Pune garden. My impression is that it is an opportunist; it does not depend on real jungle conditions, does very well on the dry Deccan and might turn up anywhere.

At various places I have taken males at damp patches and on soil made attractive to them by cattle, though I have not seen them on actual droppings.

In May, 1964 I took a few, mostly males, at Ranikhet and Jolikot between 1,100 and 1,800 metres in the Central Himalayan foothills. A genitalia check showed them all to be *nora*, and not, as I had hoped, the outwardly similar *Prosotas pia marginata* Tite, 1963; this has not been found west of Sikkim, so mine was a long shot.

I reared this species from larvae found on the pink and white flower-heads of an *Acacia*-like bush in our Pune garden, probably *Mimosa hamata* Willd., but I was never able to find an egg in spite of quite often seeing a female laying. Bell (1918): 656, says 'each egg is deposited near the base' of a bud, well concealed from casual observation, the end of the 'abdomen being thrust well down between the heads.' At Mahableshwar in 1971 I set myself to find an egg; I pulled off each part of an inflorescence and eventually found the egg shown on Plate V. Unfortunately in the rush of a short visit to India I did not keep for identification a specimen of the bushy herb with purple flowers on which numbers of *nora* were laying at Mahableshwar. The photograph of the egg tallies with Bell's detailed description; I reproduce it here so that those who cannot refer to back numbers of the Journal may not miss an example of his unsurpassable and dedicated work. Bell (1918): 654-655:

Egg. Turban-shaped. The surface covered all over with reticulations forming cells, the walls moderately broad and high, especially just at the change between the flat, somewhat depressed top surface to the perpendicular sides, where the intersections are thickened and prominently raised into little round-topped prominences, which are erect, slightly flattened above and below, and shining. These prominences lose themselves towards the base, as well as very soon after they get over the rim on to the flat top. The highest prominences are quite the height of one cell diameter where they are. The largest cell is just over the rim on the side (of the egg) of which it takes up most of the height. The cells in this ... row are all hexagonal, and from each prominence radiate six thin rays to the intersections surrounding it. (Nearly) all the other cells are ... more quadrangular, and decrease in size from the rim to the centre of the top, but not rapidly. Those around the central, irregular, low-walled surface containing the micropyle are seven or eight in number, somewhat distorted, and the smallest of all. The rows of cells are arranged ... in wide sweeping curves, all, theoretically, having their origin at the micropyle, and curving out like the picture of a catherine-wheel firework. The bottoms of all the cells are finely granulated, and that of the micropyle-surface is pitted. The whole surface is shining like glass in a strong side light. The *colour* is very light bluish-greenish to the eye; under the lens all the walls and prominences are white and the bottoms of the cells greenish.

Breadth: 0.4 mm; *height*: 0.2 mm.

Larva.

I reared several found in the Pune garden on *Mimosa hamata* during the last two weeks of August. Some were in the early stages, yellowish in colour, without noticeable markings. Others, a little bigger, had lateral and dorsal rows of spots, orange on the back, darker at the sides. The dorsal row was contained in a yellow stripe. The ground colour was green or light yellow. A larva 5 mm long, which would be about half grown, had raised tubercles on the back; the dorsal spots were light in colour, most definite on the thoracic segments and, in the case of the lateral spots, most definite on segments 5 and 11. I got only a fleeting glimpse of the head of this larva; like many Lycaenids they keep their head drawn into the thorax most of the time, even when eating. Another larva, nearly full grown when found, was pale green, the same colour extending into the true legs. For the next two days it remained on the same flower head where I had found it; when that began to wilt it refused to move over to fresh food, as if concealment was of greater importance to it than diet. All these larvae were hard to observe, spending their time well down among the flowers they were eating. The presence of larvae was indicated, though not constantly, by small black ants. Apart from these it was very hard to find the larvae which blend marvellously with the flower heads as well as as being usually half buried in them. They eat only flowers and flower buds; I never saw them attack the leaves. There were always some small black insects on the bush as well as the ants; I once saw one of the former on the back of a *Prosotas* larva; I much regret having neglected to collect either of these for identification.

Pupation.

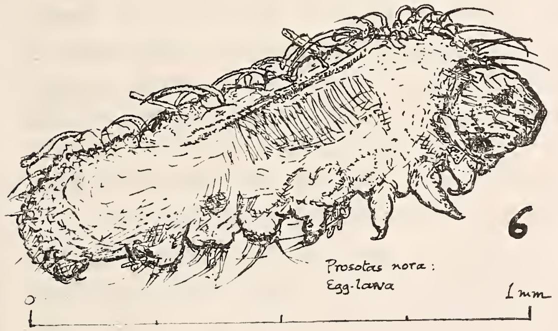
Sometimes the larvae pupated in the angle at the top of the cage, but mostly at the bottom among debris. Wherever they chose to pupate they were well attached by pad and girdle, often to a stalk or a firm bunch of leaves.

The cage used was probably a plastic container, but this is undesirable for 'Nacadubas'. Those reared in this way sometimes failed to expand or had soft wings. At the time I thought this was due to the absence of ants from my cages, but after subsequent experience with *Nacaduba pactolus* and *berenice* I believe ventilation and growing plants are more important. A snag about *Mimosa* species as a foodplant is that the flowers tend to drop from a twig kept in water in a gauze cage.

The butterflies emerged about six days after the pupa was fully formed. The time of emergence was about midday. A female pupa skin is illustrated in Fig. 7, showing the segments of the abdomen from below.

Adult Wing Pattern.

I have seventy males, mostly from the Deccan and the Western Ghats, collected in twos and threes at different times of the year between 1951 and 1974. Above, they vary in tint from a dark purple through violet almost to a blue. These prismatic colours are best seen and compared in a side light. Looked at directly, less purple or violet shows, and the main impression is brown, coffee-coloured to sooty. Since few caught specimens are mint-fresh, the lighter browns are probably the result of bleaching and delapidation during life.



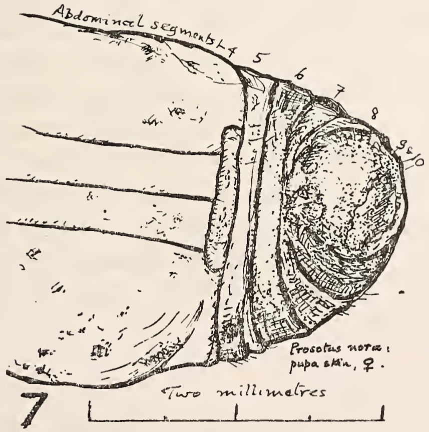


Fig. 6. Egg-larva: *Prosotas nora.* Fig. 7. Pupa skin: ♀, *Prosotas nora.*

About forty females collected over the same period vary above in the extent of blue on the discs. Blue is nearly always absent from the hind wing. On the forewing there are at least some blue scales in nearly every case. There may be a complete row of dusky marginal spots on the hindwing, but these may often be reduced or absent, except always the larger tornal spot. The marginal spots may be clearly or faintly outlined with pale ochreous. There is always some indication of an ochreous line before the dark threadlike border, especially towards the tornus; here the ochreous line may be nearly white, as may be seen by comparison with the pure white tip of the 'tail' at vein 2. The marginal spots may be darker than the ground-colour of the wing, but so far as I have seen not darker than the tormal spot.

Below, in both sexes, the ground colour of the wings varies from grey to brown. There is great variation in the catenulated bands, both in their exact disposition and in the amount and intensity of dark scales between the pale strigae. I cannot see regular seasonal variation here; a well marked example may be found at any time of the year. The variation seems to be individual.

Three of my females have an unusual dull yellow tint on the undersides. From breeding experience, Bell (1918): 654, attributes this to development during heavy rainfall. Thus two of my females, taken in May, would have experienced thunder showers during their early stages; the third example was taken in Pune on 28.ix.1957, having grown up during the moderate rains of the district. It would seem that the yellow form may appear in the dry season if conditions for that particular insect happen to have been damp enough. Why this variation should occur only in females is an interesting problem. In the Andamans, the females have very bright yellow undersides. See Evans & Cantlie (1962): 80.

The Male Genitalia.

Plate XVI: 37 is a side view of the complete armature. The left brachium and the left valva are omitted. The genitalia of the three *Prosotas* species studied here appear to me to be very similar. Table 6 gives the slight differences I can suggest.

Aedeagus: The broken tissues at the base of the aedeagus may indicate the presence of a well developed coecum. The feathery processes on both sides of the aedeagus begin about half way up, and end a short distance after the branching-off of the Chapman's process.

Valva. Fig. 5 (a) is of the inside of the left valva, dorsal side to the right. There is a clear ridge along the apical hook tending towards its distal side. The dark area on the main body of the valva consists of minute spicules, not clearly discernible at about 100× magnification. There are crenellations on the dorsal edge from below the apex to about halfway to the base.

Notes on the Anatomy of the Egg-larva.

Fig. 6 was drawn from a slide of a larva collected at Mahableshwar in November, 1971. Its identity is very probable as the females were laying there in numbers, and the adults bred out were all *nora.*

Unfortunately I did not fix the specimen in Pampel's, so that it is not so well preserved as that of *N. pactolus* and does not make a good comparison possible.

It seems that the *Prosotas* larva is hairier than *pactolus,* and the dorsal hairs shorter and less erect. In the slide the head of the larva has turned dorsally. The surface of the body appears to be minutely tubercular. Some of the dorsal hairs are curved and pointed, with serrations on the front edge; others are similarly serrated but straighter and blunt ended. In contrast to *pactolus,* the false legs are furnished with long smooth hairs and some shorter club-shaped hairs. The anal end of the larva bears numerous prominent smooth, curved hairs and some short, club-shaped hairs.

VII. **Prosotas dubiosa indica** (Evans, 1925).
(Plates XII, XIII & XIV)

This race of the species ranges from Sri Lanka, the Indian peninsula and Burma to the Andamans; other races are named for Malaysia and the Solomons. The typical race is from Queensland.

Apart from the lack of 'tails' on v. 2 of the hindwing, *dubiosa indica* is very similar to *nora ardates.* Comparing my long series of the two forms, collected in small numbers over about twenty-five years, I would say that the males of *dubiosa* are on the whole of a brighter purple, and that the females have less blue on the disc of the forewing.

So far as I have observed, *dubiosa* has the same habits as *nora,* flying in the same restless fashion around trees and bushes, and attracted by mud, damp and the rich odours of cattle droppings. This applies to males, though once, in the Pune garden I took a female on damp earth. Both sexes come to flowers; I have noted the garden forms of *Verbena, Ageratum* and *Celosia,* and the jungle tree *Dalbergia,* as well as the larval foodplants. These I have noted as *Acacia* spp. especially the bushy kinds, *Mimosa* sp. and *Leucaena* sp., all of which belong to the *Mimosaceae.*

The Male Genitalia.

Plate XVI: 38 is of the complete armature, side view from the right, the left valve and left brachium omitted. The furca ought to

be anchored between the valvae as in the other *Prosotas* drawings.

Aedeagus: There is a well developed coecum of the shape dotted in, warranted by several other dissections, none of which are perfect. The ductus entering dorsally is indicated by sketchy lines. In the slide the feathery structures are a striking feature, extending from the apex down as far as the zone. As it is impossible to represent these heavily chitinized striations accurately at the scale, I have been content merely to show their position with a few lines.

Valva.

Fig. 5 (b) shows the inside of the left valva, dorsal side to the right. There seems to be considerable concavity, especially dorsally. As in *nora,* there is an area of dense, tiny spines on the main body of the valva, and the dorsal edge below the hooked apex is crenellated, the hook itself being ridged.

VIII. **Prosotas noreia** (Felder, 1868).
(Plates VIII & XIV)

There are three named races of this species; the typical one is *P. n. noreia* (Felder, 1868) from Sri Lanka and Burma; *P. noreia hampsoni* (DeNiceville, 1885) is the Indian race, recorded from S. India up to the foothills of the central Himalayas; and *P. noreia cyclops* Toxopeus, 1929 from Java.

The underside pattern of the first two races is illustrated in Plate XIV. The Sri Lanka race is the smaller and more delicately marked. In my seven examples of *hampsoni* the prominent postdiscal spots on the forewing below are joined almost to form a band, especially in the males. In both male and female the spots in spaces 2 and 1b are either not shifted inwards at all or not completely, so that the bandlike effect is produced. In my one example from Sri Lanka, the postdiscal spots are more separated and those in 2 and 1b are well shifted in.

The underside feature distinguishing this species from *dubiosa* is that the basal band on the forewing is confined to the cell. I have often found, to my disappointment, that what I thought was a *noreia* was a *dubiosa* very faintly marked in 1b.

The upperside colour of the male is 'intense lustrous purple' as stated in Evans & Cantlie (1962): *ad loc.*, but I do not think this applies to the female as stated there. My three *hampsoni* females have blue, definitely not purple, on the discs of both wings, as noted by Woodhouse & Henry (1942): 91, para. 115. Although I have two perfect males, I do not find the cilia at the tips of the forewings prominently white, but can distinguish this with top lighting under low magnification.

On the uppersides of each of my three females there is some darkening of the cilia of both wings in line with the vein ends; see Plate XIV, of a near-perfect example. I have not noticed such darkening in *nora* and *dubiosa.* The effect is not of strong contrast, as, for instance, in the 'laddered' cilia of *Talicada.*

From what could be observed from the eight examples I have been fortunate in capturing, the habits of this rare species are similar to those of the two common *Prosotas* already considered. One male and two females were taken at *Vitex* flowers. The others were caught around bushes or at damp places. The Sri Lanka male was taken around bushes at sea level where there were *dubiosa* in plenty. The Indian *noreia* are from three places on the Western Ghats, between 600 and 1,300 metres altitude. At one of these spots a female was taken low down on leaves of *Osyris*; numerous small 'Nacadubas' were jigging around a *Terminalia* near by, occasionally settling on bushes. By their behaviour these seemed male butterflies, but I failed to catch one. From time to time the mad dance ceased and the insects went into the undergrowth, reappearing after about ten minutes. It is possible that I was witnessing part of the courtship of *noreia*; at least the species was present. Perhaps *Terminalia* is a foodplant, or in this case happened to be right for the game. *Osyris* is a shrub with angular branches, alternate leaves and small unisexual flowers, belonging to the Santalaceae. I took a male in another place on the Ghats in a sunny clearing in thick jungle; most of the catch was *dubiosa*. It does look as if the two species often fly together.

This concludes the account of the eight 'Nacadubas' which I have met with in the field. I hope many collectors, especially lovers of the Lycaenidae, may have the sort of experiences I have had, including hot, frustrating hours at prickly bushes on uncomfortable hillsides! In this way they might well find out that this beautiful *Prosotas noreia* is less disjointedly distributed than supposed, or even that it is not so rare after all.

Male Genitalia.

Plate XVI: 39 is of the complete armature in side view, dorsal side to the right. It shows the characteristics of the genus — valves with a well defined point, aedeagus of squat shape with a single, well separated Chapman's process. The left valva and the left labium are omitted in the drawing.

Aedeagus. The zone is clearly defined in this slide, just below the Chapman's process. As in the other two *Prosotas* studied here, there are feather-like processes on either side of the aedeagus. They are extensive in this species, from near the base to well past the zone towards the apex. There is probably a large coecum as in *dubiosa*; my material is damaged at this point.

Valva. Fig. 5 (c) is the inside of the left valva, the longest of the three species studied. There is a slight crenellation dorsally. The ventral edge is partly folded over. Below the apex the main body of the valva is fairly concave.

Notes on Preparing Male Genitalia.

These are made either into slides for keeping separately, or mounts for keeping with the pinned collection. The latter has advantages; in practice both methods will be needed.

The process sounds more complicated and troublesome than it actually is. Moisten the end of the abdomen of a pinned specimen with spirit. Too much spirit may run up into the wings and distort scales. When the material seems well soaked, cut off the last two segments of the abdomen with dissecting scissors or fine nail scissors. With practice and luck, you will not always break off the whole abdomen. Place the segments containing the genitalia into a test tube of potassium hydroxide 5% (caustic potash) a couple of centimetres deep. Cork the tube and pin a data label on at once. Leave the material for 12 to 18 hours, depending on size. There is little risk unless you should leave the material much too long when the hard parts might be damaged. After the proper time, which you will soon get to know, the material will be ready for the next stage. Alternatively it may be prepared for this by boiling, though there are more risks, especially to small genitalia. For boiling you close the tube with cotton wool; a long pin pushed sideways through this stopper holds the data. You then hold the tube in a vessel of water which is brought carefully to the boil, then kept simmering for up to twenty minutes. A wooden bridge with holes for the tubes can be easily devised. If, at first, the material floats, it is ready when it sinks. Use a large test tube for boiling.

After boiling or soaking, transfer the material to plain water, and after a moment on blotting paper, to a dish of spirit. The best dish is the excavated kind which is hard to knock over. Ordinary methylated spirit is all right, even the coloured product.

Having made sure of the data, you next (under magnification) tease away the outer covering of the segments in the spirit. If it is ready this outer coat, along with the concertina-like body-wall, will peel off easily. If not, boil or soak a little longer. Some people are able to use a strong watchmaker's lens or similar device. The alternative is a stereo-microscope, which gives a true image, not reversed. The tools for dissecting are fine forceps, mounted needles and the smallest painting brush.

When you have picked off and brushed away the soft parts as thoroughly as possible you have the pleasure of seeing the whole armature perfect with its components easily movable. Put it in clean spirit and work out which part is which, and plan the position you will mount it in. You may now decide to detach a clasp for mounting separately on this or another slide. Or you may want to extract the aedeagus, mount it separately, and show the valvae and labides expanded and flattened.

The next thing is to clear the water out of the specimen. Transfer it via blotting paper to a dish of xylene for ten minutes or more; you can see the bubbles escaping and the material becoming semi-transparent.

While clearing continues, polish a thin microscope slide, stick a label on it near one end, and lightly pencil in sufficient data. Then place a card ring in the middle of the slide, and with a glass rod, or smooth, thin knitting needle, drop in a *small* quantity of canada balsam. This is the fixing agent. (Instead of canada balsam, Euparal is now recommended). There should be enough balsam to fill the ring and to fix it to the glass slide.

Next place the cleared specimen in the balsam, and with two needles arrange it under magnification. This can be tricky, as air bubbles tend to appear and the balsam resists your movements. The difficulties are reduced by frequently dipping the needles in a dish of xylene.

When the material is well arranged, drop a little extra balsam onto it so that the surface of the fixative is slightly convex. Now take a round cover glass (which has been waiting in a safe place). Hold it by the edge with forceps. Getting on a level with the slide, place the edge of the cover glass upon the cardboard ring, and lower the other side gently to cover the whole ring. The balsam will have flowed across the specimen towards your hand without leaving air bubbles. If it looks as if bubbles are going to obscure just what you want to see, take off the cover glass, rescue the material wipe up the balsam and begin again. This is better than topping up the balsam in the ring.

The data are written as soon as possible with waterproof ink on the label. This is vital. Always give enough data to connect the material with its source in the pinned collection or wherever it is. It is best to give full data for the sake of anyone who may own your slide in the future, but may not be able to refer to your collection.

Cardboard rings can be made with a hammer and punch. The rings for the 'Nacadubas' were of postcard thickness. They look well enough if trimmed round the outside to produce a circle slightly larger than the cover glasses.

For cover glass mounts, stick (with balsam) what is to be the lower glass over the hole in a punched and pinned card ring mount. Let it dry overnight. Then reverse it on the pin and proceed as for a slide. A serial number corresponding with that on the data label of the material in the slide mount may be written on the card of the mount near the pin. In making these mounts leave enough card beyond the cover glasses for the pin. The mount may go on the pin under the insect itself, or stand on its own pin with its duplicate data label. In all cases there must be no chance of muddling the data, especially as sometimes the mount will have to lie on the microscope stage without its data label and pin.

Slides and mounts must dry flat in a dust-free place. This takes time. A slide on which too much balsam has been used may still be sticky after several months. If the pinned insects are in boxes stored on end, the genitalia in mounts which you may keep with them are liable to change position, unless the preparations are absolutely dry before being put in the collection.

I did the figures of genitalia mostly at 100 × magnification with the aid of a squared graticule in the eyepiece. By calibration it was possible to give measurements and scales, errors in which will therefore be constant.

Conclusion

The butterflies of the *Nacaduba* complex began to appeal to me in 1950 after the late Mr. Nogueira of happy memory, identified for me my first *Prosotas dubiosa* at the BNHS and my interest and delight in them has grown ever since.

It should be realized that the lepidopterist who can visit jungle and hill country, as on the Western Ghats, is greatly privileged; but also that a good deal of fascinating work is open to those who are rarely able to take their net beyond the gardens and waste plots of Indian cities and suburbs. Anyone might find *Petrelaea dana*, for instance, in Salsette; or you might get *Ionolyce helicon viola*, as Best did in the late forties. See Best (1951): 338.

Only the simplest equipment is needed, for a microscope is only essential when you get on to genitalia. Next to the net, a field notebook is of great importance, written as soon as possible after an observation. I well know how bits of paper get lost; also how a statement, clear (it seemed) when made, can read ambiguously years later.

I hope these notes of an enthusiast will provoke others to take up one of the less known butterfly groups. It may be the Hesperids or the Satyrids that attract you — they are well worth it. But if you are beginning to feel the pull of the Lycaenidae, then go straight to the nearest lime-bush with a hand lens and get going on the ant-relationship of the larvae of *Chilades laius*!

Acknowledgements

I am very greatly indebted to the late Mr. G. E. Tite for advice and encouragement during the preparation of this paper; for confirming the identification of my *N. berenice* material; for showing me how to prepare genitalia; and for his skill and considerable ingenuity in producing the drawings of androconia. And his 'Synonymic List', noted below, has guided me throughout.

I am also indebted to Prof. G. C. Varley for allowing me every facility, including access to the Hope Collections in the Department of Entomology in the University of Oxford. Mr E. Taylor of that Department was, as always, a great help to me in several practical matters.

The section on Zoogeography was inspired by Col. J. N. Eliot's 'Higher Classification of the Lycaenidae'. As stated in the text, any misinterpretations or rash conclusions are my own. I am grateful to Col. Eliot himself for so kindly presenting me with a copy of his work. I have referred to it constantly, and it continues to illuminate my general study of the Lycaenidae.

I thank the Trustees of the British Museum (NH) for allowing me to use the map showing the distribution of *N. astarte* in Tite (1963).

Father F. L. Wain, my colleague and friend, has supported me throughout the lengthy gestation of this paper. Father E. F. Bishop, also with great understanding, and Mrs Jane Woolmer, between them photographed the adult insects. I am very grateful to them both for their patience and skill. And I thank Br Alban Waite of my Society for his accurate work in mounting all the drawings and photographs, and for binding the typescript.

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NEW DESCRIPTIONS

TAXONOMIC STUDIES ON MARINE OSTRACODA FROM THE EAST COAST OF INDIA. FAMILY: CYPRIDIDAE MARTIN, 1940[1]

C. ANNAPURNA AND D. V. RAMA SARMA[2]

(*With three plates*)

INTRODUCTION

In an investigation on the taxonomy and ecology of benthic ostracods, 40 species belonging to 27 genera and 14 families were identified from the marginal marine/estuarine environments, namely Bimili backwaters (17° 54′ N; 83° 28′ E), Balacheruvu tidal stream (17° 39′ N; 83° 15′ E), and Vasishta Godavari estuary (16° 18′ N; 81° 42′ E). (Annapurna 1978).

Among the members of the family Cyprididae Martin, 1940, *Phlyctenophora indica* is new to science, *P. zealandica* (Brady, 1880) is recorded for the first time from Indian waters.

Family: CYPRIDIDAE Martin, 1940
Subfamily : PARACYPRIDINAE Sars, 1923
Genus: *Phlyctenophora* Brady, 1880

KEY FOR IDENTIFICATION TO SPECIES OF *Phlyctenophora*:

1. Carapace smooth 3
2. Carapace sculptured with a few pits and dark brown patches in live condition 6
3. Antero-dorsal pronounced .... *Phlyctenophora bhatiai*
4. Antero-dorsal not pronounced 5
5. Marginal pore canals conspicuously branching .... *P. zealandica*
6. Bifurcate branching in marginal pore canals .... *P. indica*

Phlyctenophora zealandica (Brady, 1880)
(Pl. 1, Fig. A; Pl. 2, Figs. 1-8)

Carapace elongate, moderately compressed laterally. Greatest height in the middle and equal to less than half the length. Anterior end broadly rounded, posterior end narrow and ventrally sub-angular. Dorsal margin arched, ventral margin somewhat sinuate in the middle, carapace smooth, valves strongly calcified. Hinge adont type. The dorsal margin of the right valve fits into a shallow open groove along the dorsal margin of the larger left valve. Inner lamella widest anteriorly and anteroventrally, narrowing towards the posterior end. Anterior vestibulum present but not conspicuously wide. Posterior vestibulum generally slightly wider. Selvage peripheral, weakly developed. Marginal pore canals many, conspicuously branched, especially anteriorly and anteroventrally. Normal pores numerous, small pores open and scattered. Central muscle scars, adductor muscle scars group of six, four in the anterior vertical row and two in the posterior and two anteroventral mandibular scars. Eye spot absent, left valve larger than the right. Sexual dimorphism not apparent.

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[1] Accepted December 1985.

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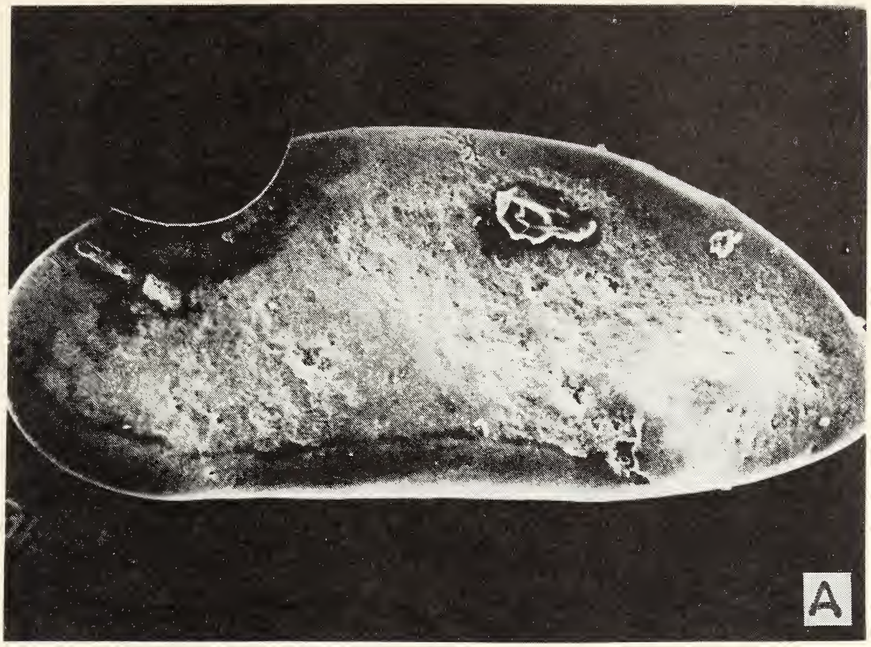
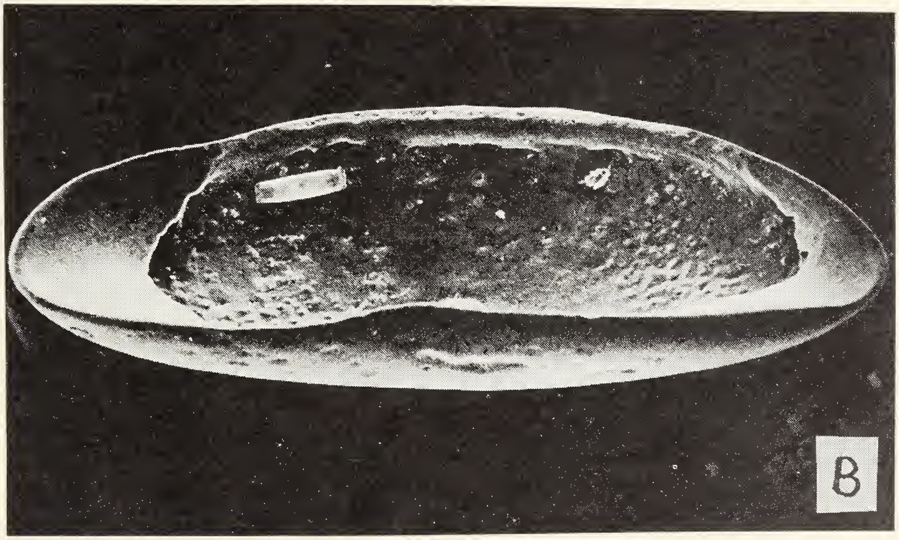
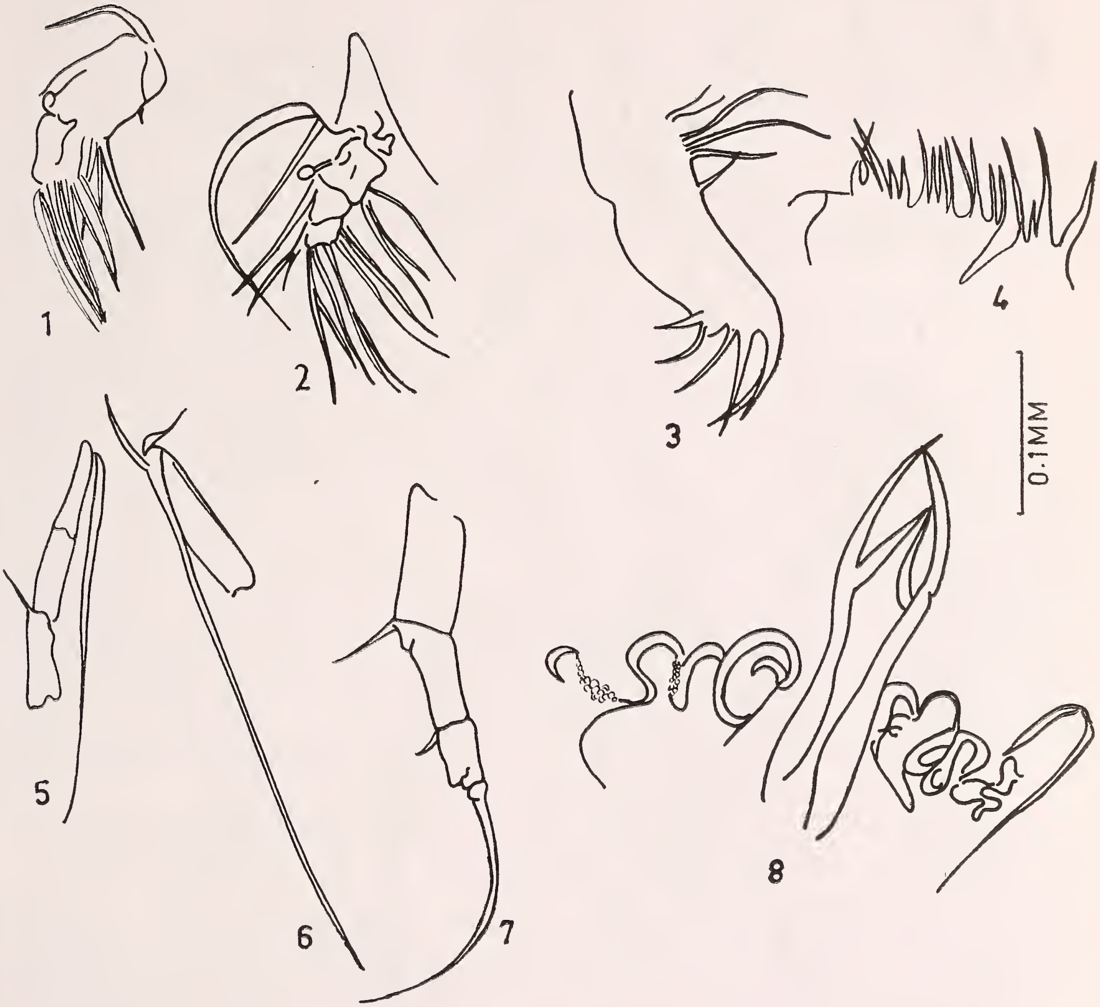


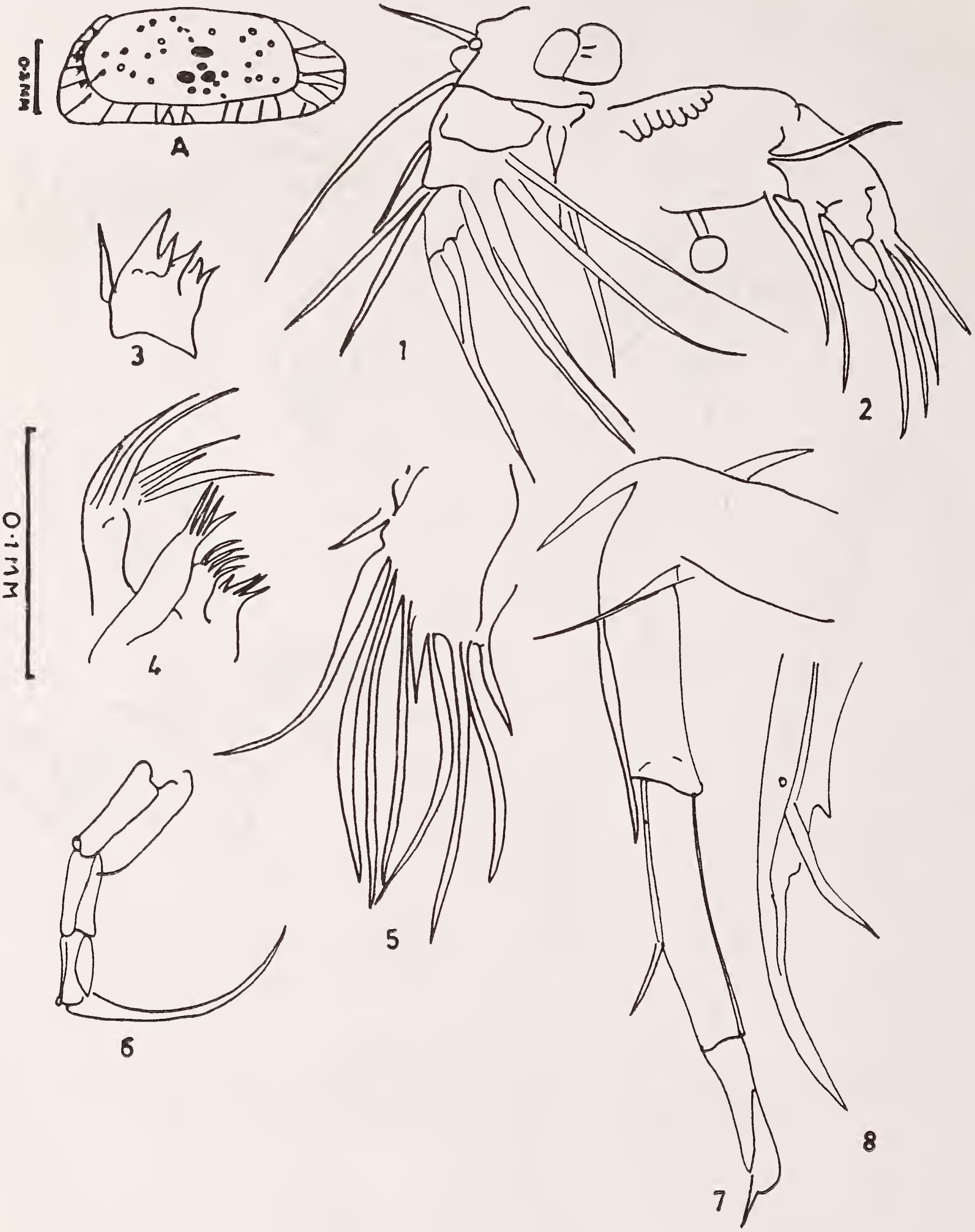


A. *Phlyctenophora zealandica* — Exterior view of carapace — 100x.
B. *P. indica* — Interior view of carapace — 116x.



Phlyctenophora zealandica (Brady)

1. Antennule; 2. Antenna; 3. Vibratory plate; 4. Maxilla; 5. First thoracic leg; 6. Second thoracic leg; 7. Third thoracic leg; 8. Genital organ.



Phlyctenophora indica sp. nov.

A. Exterior view of the left valve.
1. Antennule; 2. Antenna; 3. Mandible; 4. Maxilla; 5. Vibratory plate; 6. First thoracic leg; 7. Second thoracic leg; 8. Third thoracic leg.

Length 0.94 mm; height 0.45 mm.

Antennule 5-jointed, first podomere with 2 slender setae. Second podomere consists of sense organ and 3 posterior slender setae. Ultimate podomere with numerous slender setae. Antenna 3-segmented. Distal ends of second podomere with numerous setae. Ultimate podomere shorter than other two podomeres, ends with slender setae. Setae help in swimming. Mandibles with 5 pairs of serrate teeth placed laterally on the cutting edge. Maxilla with 4 masticatory lobes end with short setae. Vibratory plate with 8 unfeathered rays, at the base of the vibratory plate with 4 slender setae. The 2-segmented maxillary palp bears 4 slender setae and ends with 4 setae. The first 3-jointed thoracic leg ends with slender setae, more elongated than the segments. Second thoracic leg same as that of first thoracic leg but it ends with claw-like setae. Third thoracic leg consists of single segment with slender setae.

Occurrence: Backwaters of Bimili, Balacheruvu tidal stream, and lower reaches of Vasishta Godavari estuary on the east coast of India.

Distribution: Indo-Pacific.

Phlyctenophora indica sp. nov.
(Pl. 1, Fig. B; Pl. 3, Figs. A, 1-8)

Carapace elongate, moderately laterally compressed, highest in the middle and equal to less than half the length. Anterior end broadly rounded. Posterior end narrow and ventrally sub-angular. Dorsal margin arched, ventral margin sinuate in the middle. Carapace with few pits and widely spaced. In the live condition some forms ornamented with dark brown patches. Hinge adont type. Dorsal margin of the rigid valve fits into a shallow open groove along the dorsal margin of the larger left valve. Inner lamella widest anteriorly and anteroventrally and narrows towards the posterior end. Anterior vestibulum present but not conspicuously wide. Posterior vestibulum slightly wider. Marginal pore canals numerous, widely spaced, bifurcate branching shown at anterior end. Marginal pore canals simple and straight at posterior and ventral end. Normal pores numerous, small scattered and open. Adductor muscle scars group of six, 4 in the anterior vertical row and 2 in the posterior and two antero-ventral mandibular scars.

Length 0.67 mm; height 0.45 mm.

Antennule 5-jointed, each protopodite bears slender setae which help in swimming. The penultimate and ultimate podomeres with 2 claw-like setae. Antenna same as that of *P. zealandica.* Antenna consists of sense club in the first podomere of protopodite — a characteristic feature of the family Cyprididae. Maxilla same as that of *P. zealandica.* Mandible with 5 pairs of serrate teeth placed laterally on the cutting edge. Thoracic legs 4-jointed, U-shaped structure. Distal end of each podomere bears 1 seta, the ultimate podomere with single claw-like seta. Copulatory organs are well developed.

Remarks: The present species appears to be closely related to *P. zealandica* (Brady, 1880), and *P. bhatiai* Jain, 1975. But it differs in having a few conspicuous pits and dark brown patches on the carapace. The species is named after the country where it is recorded.

Type-locality: Balacheruvu tidal stream, East coast of India.

Type-specimens: Holotype and two paratypes are deposited in the Museum of Zoological Survey of India, Calcutta, India.

Occurrence: Backwaters of Bimili, Balacheruvu tidal stream, lower reaches of the Vasishta Godavari estuary, east coast of India.

ACKNOWLEDGEMENTS

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REFERENCE

ANNAPURNA, C. (1978): Systematics and ecology of benthic ostracoda from selected marginal marine environments, east coast of India. Ph.D. thesis submitted to the Andhra University, Waltair.

SIX NEW SPECIES OF *TENTHREDO* LINNAEUS (HYMENOPTERA: TENTHREDINIDAE) FROM NORTHERN INDIA[1]

DEVINDER SINGH AND MALKIAT S. SAINI[2]

(*With twenty nine text-figures*)

Six new species of *Tenthredo* are reported from the hills of Northern India, viz. *T. icari, T. manii, T. scabrocephala, T. flatoserrulata, T. auratotarsus* and *T. alami.* Apart from illustrating the genitalia, the new species have been separated from already reported related congeners. The population variation, if any, has also been discussed.

INTRODUCTION

Though taxonomic work on Indian *Tenthredo* is quite scattered, Malaise's (1945) paper is such an exhaustive study that, in addition to compiling almost all the earlier works for southeast Asia, it adds 18 new species of this genus from India. Muche's (1982, 1983) are the only works after Malaise (1945), which make an addition of three new species to the earlier census of Indian *Tenthredo* and bring the total number of species described so far from this country to 82. In the present study, which is one of a series of papers dealing with new records of *Tenthredo* from India, six new species are reported from the northern region.

The terminology used by Ross (1937, 1945) and Malaise (1945) has been followed.

The holotypes and paratypes are presently lying in the authors' collection and will be submitted to IARI, Pusa National Collection, New Delhi (India), after this paper is published.

Tenthredo icari sp. nov.
(Figs. 1, 7, 13, 19, 25)

FEMALE: Average length 11.6 mm. Body black, yellowish are: underside of antennal segment 5, and 6-9 entirely; mandible except extreme apex; face below antenna; extreme tip of supraantennal tubercle; narrow inner orbit; lower 1/3 of hind orbit; spot on temple without touching eye; broad dorsal angle and antero-lateral spot on pronotum; tegula; triangular apex of mesonotal middle lobe; meso- and metascutelli; large spot on appendage;

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anteromedial spot on metapostnotum; large spot along convexity of mesepisternum; metepisternum; hind margin of tergum 2 broadening towards lateral side and deflexed sides of 2-7; medial elliptical spot along hind margins of terga 3-7 (more prominent on 8) and 9 entirely; hind margin and 3 spots on each sternum; trochanters and adjoining parts of coxae and femora; proximal 3/5 of metatibia and tarsus entirely. Distal half of profemur anteriorly, pro- and mesotibiae and tarsi, except infuscated tips of tarsal joints, yellowish brown. Wings yellowish hyaline, forewing infumated towards apex, costa and stigma reddish brown, venation dark brown to black.

Antenna slightly compressed towards apex, 2.5 × head width, segments 3 and 4 in ratio 5:4; clypeus (Fig. 1) narrowly, roundly incised upto 2/7 of its medial length; labrum broader than long in ratio 4:3 with deflexed and roundly pointed anterior margin; malar space 1.5 × diameter of lateral ocellus; LID: IDMO:EL = 2.0:2.8:2.2; OOL:POL:OCL = 3.2:1.0:2.0; frontal area below level of eyes; supraantennal tubercle strongly raised and abruptly cut off from low frontal ridge; median fovea deep in anterior half only; circum-, inter- and postocellar furrows distinct; lateral furrow narrow and sunken; postocellar area subconvex with faint indication of longitudinal carina, broader than long in ratio 8:5; head slightly narrowing behind eyes; ITD:ICD =3.5:1.0; mesoscutellum roundly raised with blunt transverse carina; appendage slightly carinate; mesepisternum obtusely raised with short carina at apex; mesosternal thorns lacking; apical tooth of claw (Fig. 7) longer than subapical; metabasitarsus longer than following 3, but distinctly shorter than all - remaining joints combined; metafemur as long as tibia.

Head subshining having minute and shallow punctures, punctures large and confluent in frontal region; mesonotum with shallow and confluent punctures along with microsculpture; mesoscutellum shallowly and densely punctured; appendage minutely wrinkled with a few distinct punctures; metanotum and scutellum almost impunctate; mesepisternum with large, shallow and almost confluent punctures; mesosternum minutely punctured and distinctly microsculptured; abdomen faintly microstriated with dense punctures on terga 4-9.

Lancet (Fig. 25) with 19 serrulae, each serrula deep and lobe-like without anterior or posterior subbasal teeth.

MALE: Length 10.1 mm. Similar to female except: antennal segment 5 yellowish barring infuscation on underside; hind orbit without black and continuous with pale spot on temple; appendage entirely black; mesosternum having medial yellowish brown spot; scape brown; all femora with a black stripe posteriorly. Penis valve (Fig. 13) and gonoforceps (Fig. 19).

Holotype: Female, Uttar Pradesh, Mandal-2300 m, 13.6.1983.

Paratypes: 3 ♀♀, with same data as holotype. 1 ♂, Uttar Pradesh, Mussorie-2000 m, 3.6.1985.

Remarks: This new species shows a remarkable similarity to *T. seriata* Malaise, 1945. However, it is distinguished from the latter on account of possessing entirely black postocellar area, partly black appendage, pale metafemur with black stripe in male, reddish brown stigma and antennal segments 3 and 4 in ratio 5:4.

In *T. seriata* postocellar area has pale medial longitudinal stripe, appendage is entirely pale, metafemur is without pale, stigma is black and antennal segments 3 and 4 are in ratio 3:2.

Etymology: This species has been named after the agency that provided financial assistance for this work.

Tenthredo manii sp. nov.

(Figs. 2, 8, 14, 20, 26)

FEMALE: Average length 14.4 mm. Body reddish yellow with following pale: face below antenna; narrow inner orbit; spot touching eye on lower hind orbit; V-shaped margin of mesonotal middle lobe and spot adjoining it on lateral lobe; nebulous spot on meso- and metepisterna. Dark brown to black are: dot-like spot on outer side of antennal segment 2, extreme tip and underside of 5 and 6-9 entirely; mandible tip; anterior half of median fovea; spot in front of median ocellus; inter- and postocellar areas; posterolateral spot on pronotum; anteromedial spot on mesonotal middle lobe and large spot on lateral lobe; lateral spot on metanotum and postnotum; parapterum; narrow border of mesopleuron all round; nebulous spot on mesosternum; anterior border of metepisternum; metepimeron. Wings yellowish hyaline, apex of forewing infuscated upto proximal end of stigma with distinct limit, hind one infumated towards apex, costa and stigma reddish yellow with infuscated spot on latter, venation dark brown to black.

Antenna compressed, 2.6 × head width, segments 3 and 4 in ratio 8:7; clypeus (Fig. 2) roundly incised upto $\frac{1}{4}$ of its medial length; labrum as long as broad with roundly pointed anterior margin; malar space 1.5 × diameter of lateral ocellus; LID:IDMO:EL = 2.0:2.8:2.4; OOL:POL:OCL = 4.1:1.0:3.1; frontal area below level of eyes; supraantennal tubercle distinctly raised, sloping back and confluent with distinct frontal ridge; median fovea deep with pit in front of median ocellus, faintly carinate in anterior half; circum-, inter- and postocellar furrows distinct; lateral furrow narrow and clear; postocellar area almost flat with faint longitudinal carina, broader than long in ratio 6:5, head indistinctly dilated behind eyes; ITD:ICD = 3.0:1.0; mesoscutellum roundly raised with faint longitudinal carina on posterior slope; appendage slightly carinate; mesepisternum obtusely raised with short and blunt carina at apex; mesosternum lacking thorns; apical tooth of claw (Fig. 8) longer than subapical; metabasitarsus as long as following 3 joints combined; metafemur slightly longer than tibia.

Head minutely and densely punctured; mesonotum densely punctured with faint microsculpture; mesoscutellum punctured like notum with somewhat larger punctures on posterior slope; appendage having shallow and confluent punctures; metanotum minutely punctured; metascutellum almost impunctate; mesepisternum uniformly and shallowly punctured with sebaceous lustre; mesosternum punctulate with faint microsculpture; propodeum glabrate, remaining terga minutely and densely punctured.

Lancet (Fig. 26) with 28 serrulae; each serrula is almost flat having 2 anterior and upto 16 posterior subbasal teeth.

MALE: Average length 12.5 mm. Similar to female except: antennal segments 1-5 with complete black stripe along outer side; mesosternum without black. Penis valve (Fig. 14) and gonoforceps (Fig. 20).

Holotype: Female, Uttar Pradesh, Mandal-2300 m, 16.6.1985.

Paratypes: 8 ♀♀, 9 ♂♂, with same data as holotype. 1 ♀, 1 ♂, Uttar Pradesh, Gobinddham-3000 m, 21.6.1985.

Population variation: Only anterior 1/3 of postocellar area black; median fovea totally black; pale colour more distinct.

Remarks: This new species is related to two species of the group having reddish yellow body and forewing with distinctly infuscated apex, viz. *T. purpureipennis* Malaise, 1945 and *T. tuberculifera* Konow, 1898. However, it can be distinguished from both of them on account of having several black markings on head and thorax, reddish yellow abdomen and legs without black, supra-antennal tubercle confluent with frontal ridge, mesosternum without thorns, mesepisternum shallowly punctured and each serrula of lancet with 2 anterior and upto 16 posterior subbasal teeth.

In *T. purpureipennis,* head and thorax are without black, 5 basal abdominal terga and tarsi are pale, tip of abdomen is black, supra-antennal tubercle is separated from frontal ridge and mesepisternum is impunctate.

In *T. tuberculifera,* apex of the abdomen is black, mesosternum has short and blunt thorns and each serrula has a single anterior and 8-10 posterior subbasal teeth.

Etymology: This species has been named in honour of Dr. M. S. Mani, a pioneer and dedicated worker in the field of high altitude entomology in India.

Tenthredo scabrocephala sp. nov.
(Figs. 3, 9, 15, 21, 27)

FEMALE: Average length 10.5 mm. Body sordid yellow, black are: antennal segment 1, extreme tip of 7, 8-9 entirely and outer stripe along remaining; extreme mandible tip; broad frontal spot anteriorly covering median fovea leaving tip of supraantennal tubercle, laterally reaching (without touching) inner eye margin and posteriorly reaching hypothetical hind margin of head; postocellar area; spot on temple continuous with frontal spot; large lateral spot on posterior side of head; narrow medial transverse stripe and spot on dorsal angle of pronotum; mesonotum except antero-lateral triangular spot on middle lobe and spot outer to scutellum on lateral lobe; mesoscutellum; appendage except lateral aspect; hind margin of metapostnotum; narrow stripe along each pleural suture and spot at apex of mesepisternum; narrow basal margin of terga 1 and 2; abdominal segments 5-9; outer stripe on metacoxa; posterior stripe along meso- and metacoxae, all trochanters and femora, pro- and mesotibiae, both ends of metatibia; proximal halves of basitarsi. Wings clear, forewing faintly infumated towards apex, stigma and venation brown to black.

Antenna stout and filiform, 1.8 × head width, segments 3 and 4 in ratio 3:2; clypeus (Fig. 3) roundly incised upto 2/5 of its medial length; labrum broader than long in ratio 6:5 with rounded anterior margin; malar space 2.2 × diameter of lateral ocellus; LID:IDMO:EL = 2.0:2.8:1.9; OOL:POL:OCL = 2.5:1.0:1.6; frontal area flat, slightly below level of eyes; supraantennal tubercle faintly raised and merging into similar frontal ridge; median fovea inconspicuous with pit inner to supra-antennal tubercle; circum-, inter- and post-ocellar furrows insignificant; lateral furrow fine, superficial and diverging posteriorly; postocellar area slightly raised, broader than long in ratio 7:4 at maximum width; head neither dilated nor narrowing behind eyes; ITD:ICD = 3.2:1.0; mesoscutellum roundly raised with distinct longitudinal carina on posterior slope; appendage carinate; mesepisternum raised to acute apex; mesosternum lacking thorns; apical tooth of claw (Fig. 9) slightly longer than subapical; metabasitarsus shorter than following 3 joints combined; metafemur shorter than tibia.

Head rough, densely punctured with faint microsculpture, hind orbit shallowly punctured; mesonotum, scutellum and appendage punctured like head; metanotum and scutellum with shallow and distinct punctures; mesepisternum and sternum having sebaceous lustre owing to minute and swallow punctures along with faint microsculpture; abdomen subshining with faint microstriations.

Lancet (Fig. 27) with 20 serrulae, each serrula is low having 2 anterior and about 15 small posterior subbasal teeth.

MALE: Average length 9.1 mm. Similar to female except: all tarsi with complete black stripe posteriorly; apex of forewing distinctly infuscated up to base of 3rd cubital cell; black stripe on metatibia complete. Penis valve (Fig. 15) and gonoforceps (Fig. 21).

Holotype: Female, Uttar Pradesh, Chopta-3000 m, 13.6.1985.

Paratypes: 1 ♀, 7 ♂♂, with same data as holotype. 1 ♂, Uttar Pradesh, Flower Valley-3300 m, 21.6.1985.

Population variation: Mesoscutellum black; terga 3-4 with narrow stripe along hind margin interrupted in middle.

Remarks: This new species exhibits some resemblance to *T. striaticornis* Malaise, 1945. However, it is differentiated from the latter in having sordid yellow thorax with black markings, antennal segments 3 and 4 in ratio 3:2, inconspicuous lateral furrow of postocellar area and strongly and densely punctured head. In *T. striaticornis*, thorax is black, antennal segments 3 and 4 are subequal, lateral furrow of postocellar area is deep and head is shining with a few minute punctures.

Etymology: The species name pertains to roughness of head.

Tenthredo flatoserrulata sp. nov.

(Figs. 4, 10, 16, 22, 28)

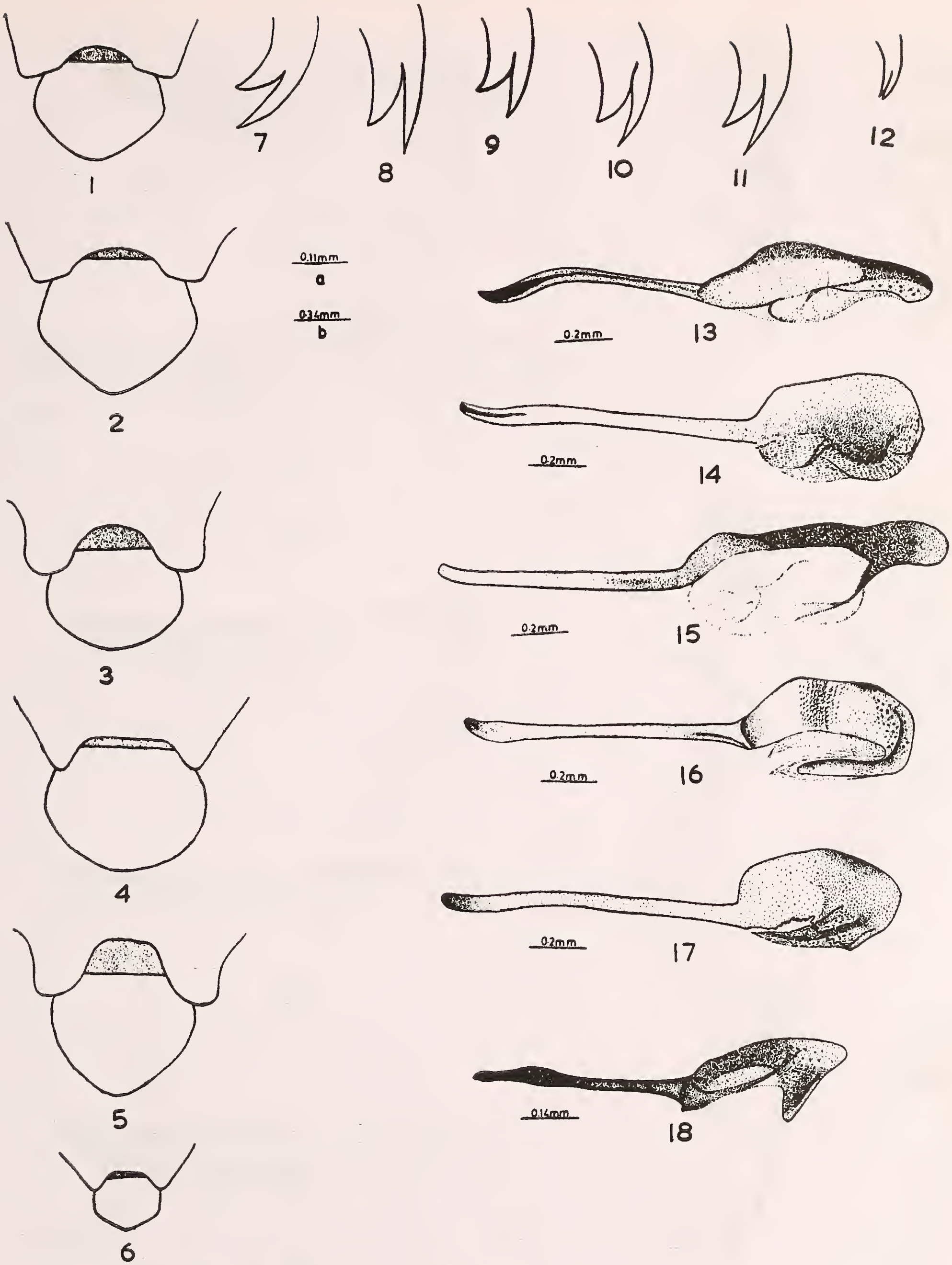
FEMALE: Average length, 10.7 mm. Body sordid yellow to pale green, black are: antenna; mandible tip; small spot outer to supraantennal tubercle; broad oblique band connecting lateral furrow of postocellar area with inner eye margin; narrow stripe along hypothetical postocellar furrow; large lateral spot on posterior side of head; transverse medial stripe without reaching lateral aspect on pronotum; seams of mesonotum and broad band along outer margin of lateral lobe; visible part of mesopostnotum; metanotum except spot lateral to scutellum; narrow hind margin of metapostnotum; band along basal margin of propodeum; broad medial spots on all terga (together appearing as a continuous band increasing in width towards distal end); posterior stripe along trochanters, femora, pro- and mesotibiae and tarsi; metatibia except narrow stripe anteriorly and tarsus entirely. Wings hyaline, fore wing indistinctly infumated towards apex, stigma and venation dark brown to black.

Antenna stout, slightly compressed in apical half, 2.0 × head width, segments 3 and 4 in ratio 4:3; clypeus (Fig. 4) roundly incised upto 1/5 of its medial length with triangular lateral teeth; labrum broader than long in ratio 5:4 with deflexed and roundly pointed anterior margin; malar space 1.7 × diameter of lateral ocellus; LID:IDMO:EL = 2.0:3.9:2.7; OOL:POL:OCL = 4.5:1.0:3.1; lower hind orbit with distinct bump; frontal area below level of eyes; supraantennal tubercle raised and confluent with similar frontal ridge; median fovea shallow; circum- and interocellar furrows fine, postocellar one absent; lateral furrow sharp and diverging posteriorly; postocellar area flat, broader than long in ratio 4:3 at maximum width; head indistinctly narrowing behind eyes; ITD:ICD = 2.7:1.0; mesoscutellum distinctly raised with acute apex; appendage carinate; mesepisternum obtusely raised with compressed and truncate apex; mesosternum with short and flattened thorns; apical tooth of claw (Fig. 10) slightly longer than subapical; metabasitarsus distinctly shorter than following three joints combined; metafemur as long as tibia.

Head and thorax minutely and densely punctured with faint microsculpture; abdomen distinctly microstriated.

Lancet (Fig. 28) with 24 serrulae, each serrula is flat having up to 25 minute subbasal teeth without differentiation into anterior and posterior ones.

MALE: Average length 10.1 mm. Similar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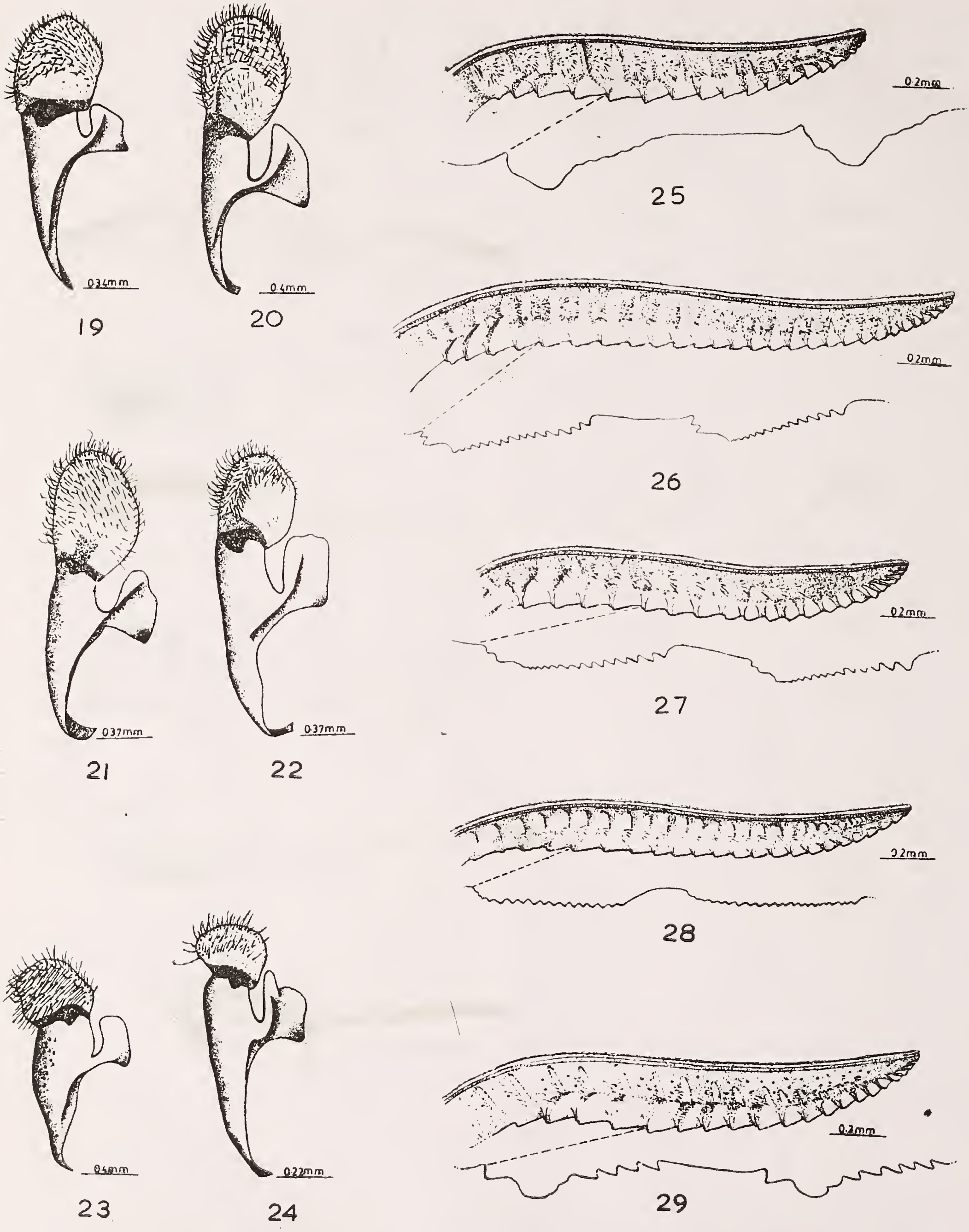
Figs. 1-18. Clypeus — 1. *T. icari;* 2. *T. manii;* 3. *T. scabrocephala;* 4. *T. flatoserrulata*; 5. *T. auratotarsus*; 6. *T. alami.* Tarsal Claw — 7. *T. icari*; 8. *T. manii*; 9. *T. scabrocephala*; 10. *T. flatoserrulata*; 11. *T. auratotarsus*; 12. *T. alami.* Penis Valve — 13. *T. icari*; 14. *T. manii*; 15. *T. scabrocephala*; 16. *T. flatoserrulata*; 17. *T. auratotarsus*; 18. *T. alami.*

Figs. 1-6 at magnification *a.*
Figs. 7-12 at magnification *b.*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Figs. 19-29. Gonoforceps — 19. *T. icari*; 20. *T. manii*; 21. *T. scabrocephala*; 22. *T. flatoserrulata*; 23. *T. auratotarsus*; 24. *T. alami*. Lancet — 25. *T. icari*; 26. *T. manii*; 27. *T. scabrocephala*; 28. *T. flatoserrulata*; 29. *T. auratotarsus*.

to female except black spot lateral to supraantennal tubercle continuous with oblique band. Penis valve (Fig. 16) and gonoforceps (Fig. 22).

Holotype: Female, Uttar Pradesh, Chopta-3000 m, 15.6.1985.

Paratypes: 10 ♀♀, 7 ♂♂, with same data as holotype. 1 ♀, Uttar Pradesh, Gobindghat-2200 m, 21.6.1985.

Remarks: This new species shows a definite relationship with *T. suta* Konow, 1906. However, it is separated from the latter in having a pale green head with black spot, mesopleuron and sternum without black, terga with black medial spots without pale hind margins, coxae entirely pale green and each serrula of lancet with 25 subbasal teeth without differentiation into anterior and posterior ones.

In *T. suta*, the head is black with some pale markings, mesopleuron and sternum are black with pale spots, terga have pale green hind margins, bases of all coxae are black and each serrula of lancet has single anterior and 10-15 small posterior subbasal teeth.

Etymology: The species name pertains to flat serrulae of lancet.

Tenthredo auratotarsus sp. nov.
(Figs. 5, 11, 17, 23, 29)

FEMALE: Length, 11.6 mm. Body black, sordid yellow to light brown are: lateral side of mandible; posterolateral spot on pronotum; front side of profemur and tibia. Spot on lateral side of propodeum, abdominal segments 2-4, pro- and mesotarsi, reddish brown. Apical 1/3 of basitarsus and remaining tarsal joints of metaleg, golden yellow. Wings yellowish hyaline, stigma and venation brown to black.

Antenna filiform, 2.6 × head width, segments 3 and 4 in ratio 5:4, clypeus (Fig. 5) semicircularly incised upto 3/5 of its medial length; labrum slightly broader than long with narrowly rounded anterior margin; malar space 1.8 × diameter of lateral ocellus; LID:IDMO:EL = 2.0:3.0:2.5; OOL:POL:OCL: 3.7:1.0:2.5; frontal area below level of eyes; supraantennal tubercle raised, sloping back and merging into low frontal ridge; median fovea broad and shallow with deep pit inner to supraantennal tubercle; circumocellar furrow absent, inter- and postocellar ones shallow but clear; lateral furrow narrow and deep; postocellar area flat with longitudinal carina, broader than long in ratio 5:3; head narrowing behind eyes; ITD:ICD = 3.0:1.0; mesoscutellum slightly raised with faint transverse carina; appendage carinate; mesepisternum obtusely raised with short carina at apex; mesosternum angled without distinct thorns; apical tooth of claw (Fig. 11) longer than subapical; metabasitarsus shorter than following three joints combined; metafemur shorter than tibia.

Head covered with large, deep and almost confluent punctures, which become smaller along hind orbit; mesonotum densely but less deeply punctured than head along with strong microsculpture; mesoscutellum with faint microsculpture and large punctures; appendage punctured on lateral sides only; metanotum finely punctured; metascutellum with large and isolated punctures; mesepisternum rugose; mesosternum distinctly microsculptured with scattered punctures; propodeum with few punctures along base, remaining terga distinctly microstriated.

Lancet (Fig. 29) with 19 serrulae, each serrula having single anterior and about 6 distinct posterior subbasal teeth.

MALE: Length 10.4 mm. Similar to female except: labrum yellowish brown; front side of protrochanter, mesofemur and tibia, light brown. Penis valve (Fig. 17) and gonoforceps (Fig. 23).

Holotype: Female, Uttar Pradesh, Flower Valley-3300 m, 21.6.1985.

Paratype: 1 ♂, Uttar Pradesh, Almora-2500 m, 25.7.1983.

Remarks: This new species is related to two Indian species, viz. *T. pulchra* Jakovlev, 1891 and *T. latifasciata* Cameron, 1877. However, it is distinguished from both in having reddish brown tergum 2, legs black with a few yellowish markings and metatarsus golden yellow, clypeus incised up to 3/5 of its medial length, frontal area distinctly below level of eyes, head narrowing behind eyes and lancet with 19 serrulae, each having single anterior and 6 posterior subbasal teeth.

In *T. pulchra*, tergum 2 is black, metaleg is totally black, clypeus is incised upto 1/4 of its medial length, frontal area is at level of eyes and lancet has 23 serrulae, each having 2 anterior and 8-12 posterior subbasal teeth.

In *T. latifasciata*, legs are reddish except coxae, trochanters and bases of femora, clypeus is incised upto $\frac{1}{4}$ of its medial length, head is dilated behind eyes and lancet has 23 serrulae, each having 2 anterior and 15-17 posterior subbasal teeth.

Etymology: The species name has been taken from its characteristic golden yellow metatarsus.

Tenthredo alami sp. nov.
(Figs. 6, 12, 18, 24)

FEMALE: Unknown.

MALE: Average length 6.2 mm. Body prasinus, black are: antenna except underside of segments 4-9; extreme mandible tip; frontal spot anteriorly covering median fovea leaving supraantennal tubercle, laterally touching eye margin and posteriorly reaching hypothetical hind margin of head; spot along upper eye margin continuous with frontal spot; postocellar area except narrow posterior margin; broad lateral and small medial spot on posterior side of head; medial transverse stripe on pronotum without reaching lateral margin; mesonotum except V-shaped margin of middle lobe and spot lateral to mesoscutellum on lateral lobe; posterior slopes of meso- and metascutelli; metanotum except spot lateral to scutellum; lateral aspect of metapostnotum; narrow, irregular stripe along proximal half of mesopleural suture; oblique band on mesepisternum upto apex; broad lateral spot along anterior margin of propodeum; medial irregular spot, constricted in middle on terga 2-8 without touching anterior, posterior or lateral margins; stripe along posterior side of legs except procoxa. Wings clear, costa and stigma pale green, venation dark brown.

Antenna filiform, 2.6 × head width, segment 3 slightly shorter than 4; clypeus (Fig. 6) incised upto 1/3 of its medial length with triangular lateral teeth and truncate bottom of incision; labrum broader than long in ratio 6:5 with rounded anterior margin; malar space equal to diameter of lateral ocellus; LID: IDMO:EL = 2.0:3.5:3.3; OOL:POL:OCL = 2.2:1.0:1.3; frontal area below level of eyes; supraantennal tubercle slightly raised and confluent with similar frontal ridge; median fovea narrow ditch-like; circum- and postocellar furrows absent, interocellar one faintly indicated; lateral furrow clear; postocellar area slightly raised, broader than long in ratio 2:1; head strongly narrowing behind eyes; ITD: ICD = 2.9:1.0; mesoscutellum subpyramidally raised; appendage inconspicuously carinate; mesepisternum obtusely raised without carina or acute apex; mesosternum lacking thorns; apical and subapical teeth of claw (Fig. 12) closely set and subequal; metabasitarsus slightly shorter than following three joints combined; metafemur shorter than tibia.

Head and mesonotum subshining with minute and distinct punctures; meso- and metascutelli, appendage and metanotum almost impunctate; mesepisternum and sternum shallowly punctured with sebaceous lustre; abdomen distinctly microstriated. Penis valve (Fig. 12) and gonoforceps (Fig. 18).

Holotype: Male, Uttar Pradesh, Valley of flowers —3300 m, 21.6.1985.

Paratype: 1 ♂, with same data as holotype.

Remarks: In Malaise's (1945) key, this new species would be near *T. nigroscalaris* Malaise, 1945. However, it is separated from the latter in possessing pale underside of antenna, frontal spot reaching hind margin of head, black bands on terga not connected laterally and black posterior slopes of scutelli. In *T. nigroscalaris*, antenna is entirely black, frontal spot reaches hind margin of head, black bands on terga are connected laterally to form ladder-like structure and scutelli are entirely pale green.

Etymology: This species has been named in honour of the well known hymenopterist, Dr. S. M. Alam.

ACKNOWLEDGEMENTS

We are grateful to Dr. D. R. Smith of Systematic Entomology Laboratory, U. S. National Museum, U.S.A., for his help and useful suggestions. The financial assistance rendered by ICAR and DST, New Delhi, for the research projects under which this work has been completed, is gratefully acknowledged.

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Abbreviations in text:

EL — eye length; ICD — intercenchri distance; IDMO — interocular distance at level of median ocellus; ITD — intertegular distance; LID — lower interocular distance; OCL — oculo-occipital line; OOL — oculo-ocellar line; POL — postocellar line.

DESCRIPTION OF A NEW INDIAN GALL-MIDGE (DIPTERA: CECIDOMYIIDAE: LASIOPTERIDI) CAUSING GALLS ON *ACHYRANTHES ASPERA* LINN. (AMARANTHACEAE)[1]

R. M. Sharma[2]

(*With fourteen text-figures*)

Lasioptera achyranthesae sp. nov., causing galls on leaf and stem of *Achyranthes aspera* Linn. in Marathwada region of Maharashtra State, has been fully described and illustrated.

INTRODUCTION

Lasioptera Meigen, basically a phytophagous genus, is widely distributed all over the world. However, a few species of this genus are associated with ambrosia-fungi. A perusal of literature (Felt 1940, Mani 1934, 1973) revealed that galls caused by species of *Lasioptera* are mostly on stems, a few are on leaves; many of these are not apparent; some of them slightly swollen and species-associated with grasses (infesting inflorescence) however, do not show any marked deformity.

The recorded host plants of this genus are from a wide range of natural orders in dicotyledons, especially Cucurbitaceae, and galls in general are rare among monocotyledons, barring reports on Graminae and one unnamed species reported to cause shoot axis galls on *Cyanotis cristata* (Commelinaceae) (Shivaramakrishna 1981).

Mani (1973) has reported gall no. 523 and leaf gall no. 815 as caused by *Lasioptera*(?) and unknown Itonididae respectively on *Achyranthes aspera* Linn. from Coromandel coast. Probably he could not collect adults from these galls and thus did not describe the species. I have collected stem and leaf galls on the same host plant from Aurangabad, Marathwada region of Maharashtra State during August and September in 1976, 1977 and 1980, and could rear a number of adult midges from these galls. On closer examination it was found to be different from known species. So the opportunity is utilised for describing it as a new species.

So far, genus *Lasioptera* is represented in India by 17 named species (Gover 1981), one more was added by Rao & Sharma (1977), the present species is the 19th.

Lasioptera achyranthesae, sp. nov. (Figs. 1-14)

MALE: Body 1.60 mm long; eyes confluent above; trophi normal; palpus triarticulate, short, sparsely setose; first segment (8:5) cylindrical, length 1.60× its maximum thickness; second segment (15:7) cylindrical, length slightly more than 2.00× its maximum thickness; third segment (29:6) cylindrical, longest of all, length slightly less than 5.00× its maximum thickness. *Antenna*: 0.25 the length of the body, with 2 + 13 segments (in holotype), variable from 2 + 11 to 12; segments cylindrical, sessile, gradually shortened distally, with two whorls of setae, circumfila low; scape (19:22) cup-shaped, pedicel (15:19) subglobose; third segment (19) confluent with and longer than fourth, with a short basal prolongation (4:5), enlargement (15:12) 1.25× as long as thick; fourth segment (15) with an enlargement (15:12) 1.25× as long as thick; fifth segment similar to the fourth; penultimate segment (10:9) with an enlargement slightly longer than thick; terminal segment (9:8)

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[1] Accepted June 1986.

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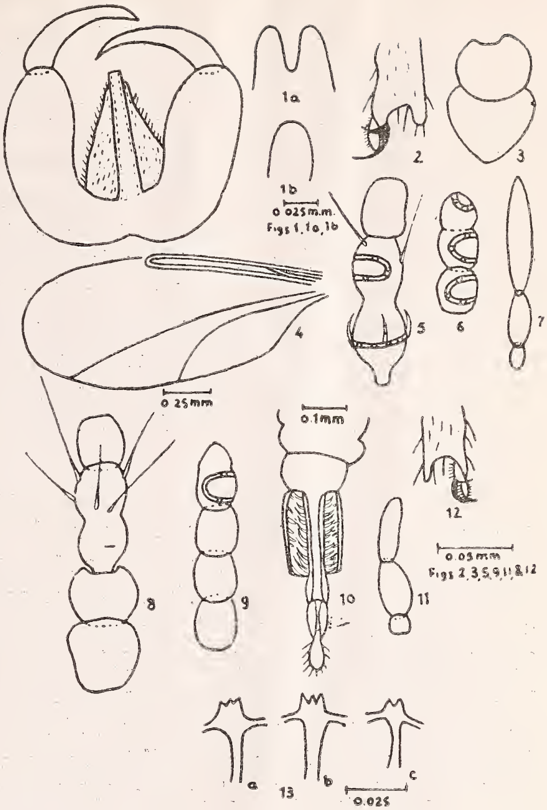
shortest of all, conical, enlargement slightly longer than thick. *Wing* (75:20) hyaline, 3.75× as long as broad; costa scaled, vein R_1 short, vein R_5 meeting costa slightly beyond the middle of the wing and interrupting at its union; vein M_1+_2 entire, vein C_u simple. *Legs* long, densely hairy, metatarsus (11) half the length of the terminal tarsal segment (22), second segment (110) longest of all, shorter than the following segments combined together (117); claw dentate on all legs, evenly curved; empodium as long as claw (14:14). *Genitalia,* light brown, basal clasp segment (59:29) cylindrical, without basal lobe, length nearly 2.00× its maximum thickness; terminal clasp segment (40:8) slender, curved, gradually tapering towards the tip, ending in a tooth, 0.60 the length of the basal clasp segment and 5.00× as long as thick; dorsal plate (25:35) deeply bilobed, lobes rounded apically; setose; subdorsal plate (15:12) entire, rounded apically; shorter and narrower than dorsal plate, hairy; parameres heavily sclerotized, triangular fringed with short, recurved setae, longer than dorsal plate, shorter than aedeagus, bifid apically; aedeagus (49:5) cylindrical, shorter than basal clasp segment, truncate apically, length 9.80× its maximum thickness.

FEMALE: Body 1.66 mm long (including ovipositor); *palpus* triarticulate; first segment (5:5) short, globose; second segment (14:7) cylindrical, twice as long as thick; third segment (18:5) cylindrical, longest of all, length 3.60× its maximum thickness. *Antenna* 0.25 the length of the body, with 2+14 segments (in allotype), variable from 2+13 to 17; segments subcylindrical, sessile, gradually shortened distally, enlargements with two whorls of long setae, circumfila low; scape (16:16) cup-shaped, as long as broad; pedicel (15:16) subglobose: third segment (16) confluent with and longer than fourth; enlargement (14:13)



Figs. 1-13. *Lasioptera achyranthesae* sp. nov. (1-7 ♂): 1. Genitalia; 1a. dorsal plate; 1b. subdorsal plate; 2. claw; 3. scope and pedicel; 4. wing; 5. third, fourth and fifth antennal segments; 6. terminal three antennal segments; 7. palpus. (8-12 ♀): 8. scape, pedicel, third, fourth and fifth ant. segments; 9. terminal four antennal segments; 10. ovipositor; 11. palpus; 12. claw; 13. a. b. c. Sternal Spatulae.

slightly longer than thick; fourth segment (14) with an enlargement (14:13) slightly longer than broad; fifth segment similar to the fourth; penultimate segment (12:10) 1.20× as long as thick; terminal segment (16:10) longer than penultimate, length 1.60× its maximum thickness. Wing, legs and claw as in male. *Ovipositor*: 0.25 the length of the body, usual lasiopteran type, three rows of spines up to the middle; terminal lobe bulbous, setose, (20:11) less than twice as long as broad. *Larva*: Whitish when young, turns reddish brown as it grows old. First instar measures 0.41-0.43 mm, second instar 0.72-1.06 mm and third instar varies from 1.35-2.08 mm in length. Sternal Spatula 0.18-2.29 mm long, distally incised by a V-shaped or W-shaped emargination forming 2-3 triangular lobes, shaft moderately sclerotized. *Sex-ratio.* In this species females outnumber the males and there appears to be only one generation in a year. *Parasites.* Three species of braconids and a chalcid (Hymenoptera) were found to parasitize midge larvae.

Holotype ♂, Allotype ♀ and Paratypes 6 ♂♂ 5 ♀♀ dissected and mounted on slides, 7 larvae on slides, ex leaf and stem galls, *Achyranthes aspera* Linn. (Amarantaceae); University Campus, Aurangabad, India, 3.ix.1976, Coll. R. M. Sharma. Subsequently reared in September, 1977 and Aug.-Sept. 1980. Types are deposited in the collections of Z.S.I., Pune for the time being and will be deposited in National Zoological Collections, Z.S.I., Calcutta.

Distribution: Maharashtra (Marathwada), Coromandel coast (Mani 1973).

Remarks: This species comes close to *L. crataevae* (Mani 1934), the only species known to have triarticulate palpi, but can be separated from it in having different proportions of palpal segments, different number of antennal segments; empodium as long as claw and ovipositor lobe bulbous and setose.

Galls: *Leaf-gall.* Mostly hypophyllous, subglobose, ovoid or fusiform, solitary, solid, glabrous, pale green when young, turn reddish-brown as they grow old, indehiscent, persistent swellings of the midrib or of the larger lateral veins; at times on apical part of the petiole which extends beyond the midrib (as noted by Mani 1973). Larval cavity axial monothalamous (enclosing a single larva inside). Ostiole hypophyllous. Usually single gall per leaf, sometimes 4-5 galls may arise on midrib of a single leaf. Size 5-7 mm long, 3-5 mm thick. This gall is practically similar to Mani's gall no. 815 (Mani 1973) reported from Coromandel coast, and may be the same species causing galls.

Stem-gall: Elongated, cylindrical, subglobose or irregular, solitary, solid, hard, woody, costate, tomentose, indehiscent persistent gall; greenish or reddish when young, becoming yellowish-brown or dark-brown as it grows old. Gall

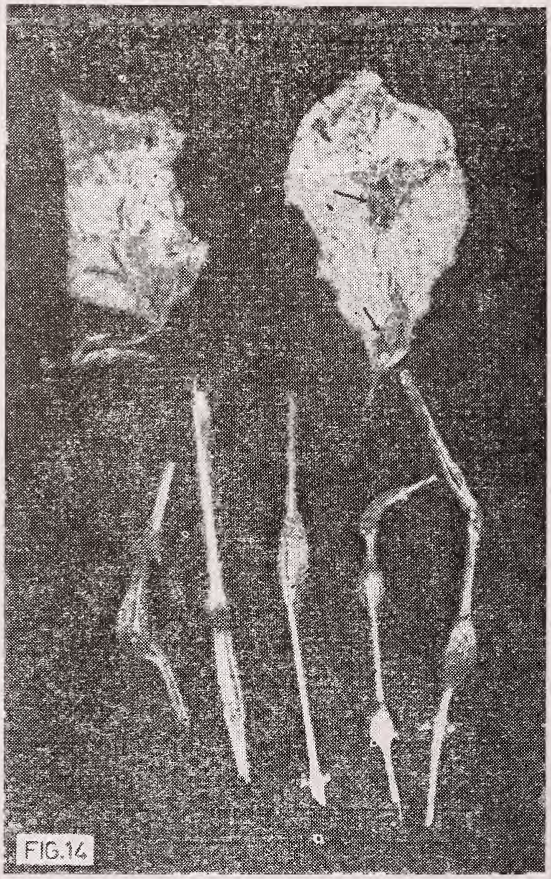


FIG.14

Fig. 14. Leaf and stem galls on *A. aspera* caused by *L. achyranthesae* sp. nov.

cavity unilocular, enclosing a single larva inside. Pupation takes place inside the gall in both leaf and stem galls. Size 7-19 mm long and 7-8 mm thick. 1-3 galls may arise on a single twig. Galls were observed from August to September, but infestation is at its peak during late August and early September. *Apamargamyia orientalis* Sharma & Rao (1978) was bred from stem galls along with this new species which is probably inquilinous species living in the galls produced by *Lasioptera achyranthesae.*

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ON A NEW SPECIES OF *DIAPARSIS* FOERSTER (HYMENOPTERA: ICHNEUMONIDAE: TERSILOCHINAE) FROM INDIA[1]

L. J. KANHEKAR[2]

(*With three text-figures*)

Diaparsis nikami, sp. nov. is described and illustrated. A key to the Oriental species of *Diaparsis* is provided.

INTRODUCTION

Diaparsis Foerster is a large genus, widely distributed in Holoarctic, Oriental and Ethiopian regions but not yet known from the Neotropic and Australian regions (Townes 1971). In the Orient this genus is known only from India. Townes, Townes & Gupta (1961) included two Indian species viz., *Diaparsis caudata* Morley, 1913 and *D. sanctijohanni* Rao & Kurian, 1951 in their catalogue from the Indo-Australian region. In the present work, a new species, *D. nikami* is described and a key to the Oriental species of *Diaparsis* is provided.

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Types and other material of this species are in the collection of the author for the time being and will be deposited in the National Collection of the Zoological Survey of India, Calcutta, India in due course.

Diaparsis nikami sp. nov.
(Figs. 1-3)

FEMALE: 4.50 mm in length. *Head* (Fig. 2): 0.85 as long as broad; vertex mat; interocellar distance 0.80 the ocello-ocular distance, 2.00 × ocellar diameter; frons weakly convex, broad, minutely, closely punctate; face 0.50 as long as broad, weakly convex, closely punctate, medio-apically sparsely punctate; clypeus 0.35 as long as broad, basally weakly, sparsely punctate, apically smooth and shiny, moderately flat, with apical fringe of parallel pubescence, clypeal fovea and clypeo-facial suture distinct; cheek 1.30 × as long as basal width of mandible, mat; mandibular teeth unequal; temple smooth, minutely, sparsely punctate; occiput smooth and shiny; occipital carina complete, joining the oral carina far from the base of mandible.

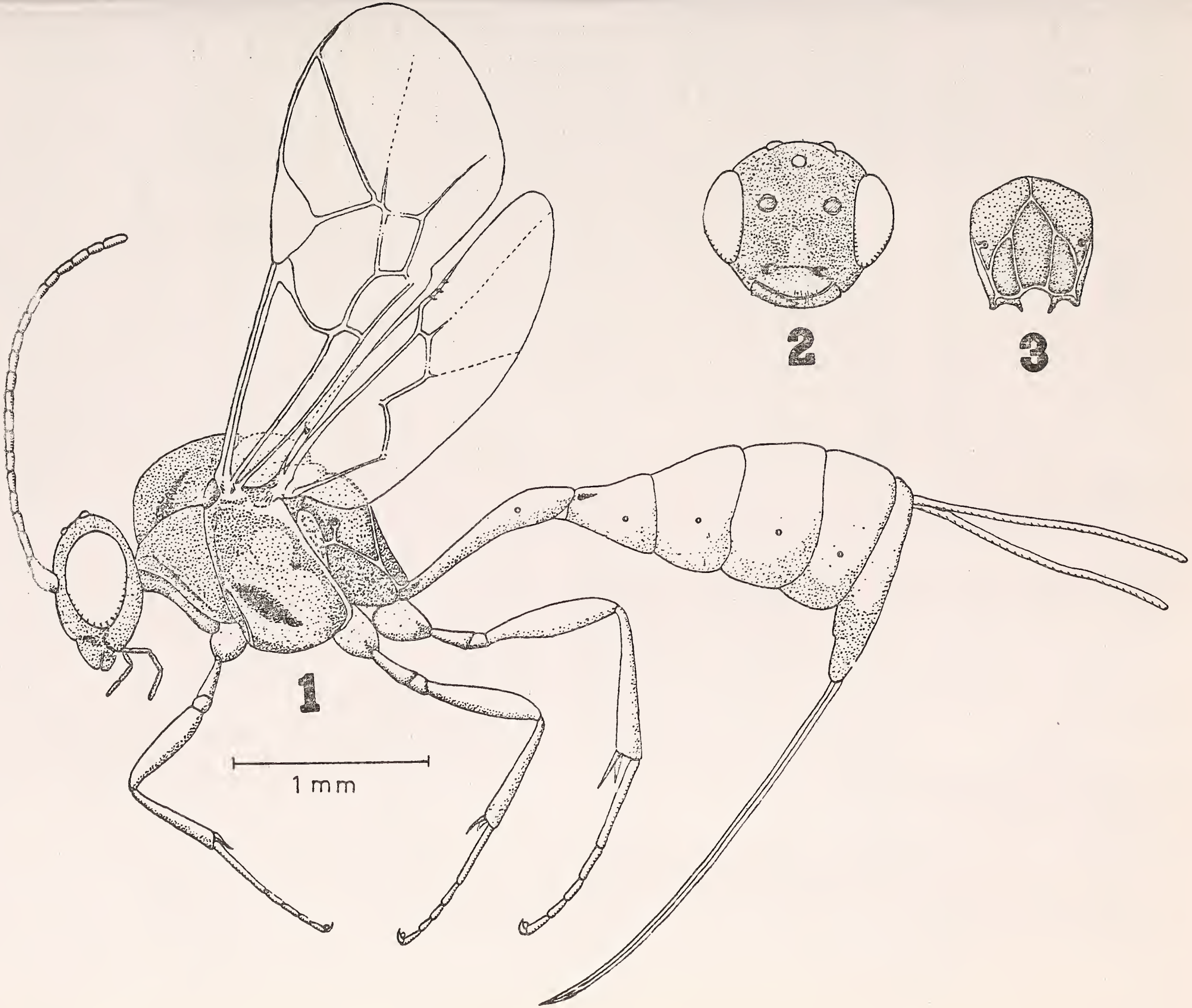
Antenna: 2+19 segmented; first flagellar segment 0.60 the length of scape and pedicel combined, 1.10-1.15 × as long as second segment; terminal segment 2.30-2.50 × as long as broad.

Thorax: 1.70-1.85 × as long as broad; pronotum densely punctate, epomia weak; mesoscutum closely punctate, notauli weakly impressed up to middle; scutellum as long as broad, convex, minutely, sparsely punctate, lateral carinae restricted to base; propodeum (Fig. 3) moderately punctate, with a single median longitudinal carina between front end of petiolar area and propodeal base, petiolar area elongate, apical lateral area distinctly carinate, rugulose, pleural carina present, spiracles small and circular, 3 × far from the pleural carina by its diameter; propleurum mat; mesopleurum antero-dorsally and anteriorly densely punctate, rest moderately punctate, with weak, slanted striate groove behind the prepectal carina, speculum moderately punctate, mesopleural fovea weak, prepectal carina reaching below the mid-height of mesopleurum and runs towards anterior mesopleural margin, sternaules absent; postpectal carina incomplete; metapleurum mat, juxtacoxal carina absent; hind femur 0.85 the length of tibia, basal tarsal segment 0.90 the length of rest of tarsus, claw simple, curved.

Fore wings: 2.65 mm long, 1.20 mm broad; stigma 2.25 × as long as broad; basal abscissa of radius 0.40 the length of its apical abscissa; areolet absent; intercubitus as long as broad, thick, as long as length of cubitus between it and the second recurrent; distal abscissa of cubitus in the form of a trace; second recurrent basad to intercubitus, 6 × the length of intercubitus, inclivous, subapically fenestrate; nervulus slightly inclivous, distad to basal vein by 0.80 its length; discoideus between basal vein and nervulus broadly thick; basal abscissa of postnervulus 2.60 × the length of its apical abscissa; second discoidal cell 1.90 × as long as broad; discocubital cell 1.55 × as long as broad.

Hind wings: 2.20 mm long, 0.60 mm broad, with 1+3 hamuli; basal abscissa of radiella short, 0.25 the length of intercubitella; apical abscissa of radiella basally with a stub, rest in the form of weak trace; apical abscissa of cubitella weakly traceable; mediella absent throughout; nervellus not intercepted; discoidella and brachiella absent.

Abdomen: 1.55 × as long as the length of head and thorax combined, moderately compressed; first tergite 4.80-5 × as long as broad apically, 2.40-2.50 × as long as the length of second tergite, smooth and shiny except laterally with weak, sparse punctures, without



Figs. 1-3. *Diaparsis nikami* sp. nov.
1. Adult, lateral view; 2. Head, frontal view; 3. Propodeum, dorsal view.

longitudinal carinae and glymma, spiracles at 0.70; second tergite 1.10-1.25 × as long as broad, thyridium longer, smooth and shiny; rest of the tergites smooth and shiny; ovipositor 0.80-0.90 the length of abdomen, weakly curved, subapically weakly notched, lower valve without a ridge at the tip; ovipositor sheath 1.80-1.90 × as long as the length of hind tibia.

Coloration: Black. Antennae basally, palpi, clypeus, mandible except teeth, tegulae, base of wings, wing veins and legs yellowish-brown; first and second tergite dorsally dark brown; second tergite laterally and following tergites, ovipositor reddish-brown; mandibular teeth, antennae apically, ovipositor sheath and stigma blackish-brown.

MALE: Essentially similar to female except in having: ocello-ocular distance as long as interocellar distance; clypeus 0.40 as long as broad; first tergite 1.85 × as long as the length of second tergite.

Holotype: ♀, INDIA: MAHARASHTRA, Aurangabad, Himayat Bagh, 21.xii.1982, on wing, coll. L. J. Kanhekar, wings mounted on slide and labelled as above.

Allotype: ♂, data same as holotype except locality and date: Bhaosinghpura, 6.i.1985.

Paratypes: 22 ♀♀, INDIA: MAHARASHTRA, Aurangabad, Cantonment, 2 ♀♀, 20-24.xii.1982, on wing, coll. L. J. Kanhekar; Himayat Bagh, 11 ♀♀, 21.xii.1982, 1 ♀, 15.xii.1982, on wing, coll. L. J. Kanhekar, 4 ♀♀, 6-9-11.iii.1982, Malaise trap coll.; Marathwada University Botanical Garden, 4 ♀♀, 25.i.1982, 1.ii.1982, 10.xii.1982, Malaise trap coll.

Comments: This species closely resembles *D. sancti-johanni* Rao & Kurian in the characters of vertex, clypeus, stigma, intercubitus, nervulus, hind wing except mediella, mesoscutum, scutellum, propodeal spiracle and hind claw. However, it differs from it in having: mesopleurum antero-dorsally and anteriorly closely punctate, rest moderately punctate, hind femur 0.85 the length of tibia and other characters as shown in the key.

The name *nikami*, is in honour of Dr. P. K. Nikam, for his contribution to the field of taxonomy of Indian Ichneumonidae.

KEY TO THE ORIENTAL SPECIES OF *Diaparsis* FOERSTER

1. Ovipositor as long as length of the body; stigma about 3.00 × as long as broad; postnervulus intercepted at middle or above the middle; antennae 26 segmented; legs red. Sternaulus elongate and deeply impressed. India .... *caudata* Morley, 1913.

— Ovipositor shorter than abdomen; stigma 2.25-2.35 × as long as broad; postnervulus intercepted below the middle; antennae 21-24 segmented; legs reddish-brown to yellowish-brown 2

2. Face faintly transversely striate; clypeal fovea absent; intercubitus basad to second recurrent; discoideus between basal vein and nervulus thin; mediella basally obsolete; hind femur slightly longer than tibia; first tergite as long as second tergite, 3.00 × as long as broad apically; ovipositor less than 0.5 the length of the abdomen. India .... *sancti-johanni* Rao & Kurian, 1951

— Face closely punctate; clypeal fovea present; intercubitus slightly distad to second recurrent; discoideus between basal vein and nervulus broadly thick; mediella absent throughout; hind femur 0.85 × the length of tibia; first tergite 2.40-2.50 × the length of second tergite, 4.80-5.00 × as long as broad apically; ovipositor 0.80-0.90 × the length of abdomen. India .... *nikami*, sp. nov.

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TWO NEW SPECIES OF *ACANTHASPIS* (HETEROPTERA: REDUVIIDAE: ACANTHASPIDINAE) FROM SOUTHERN INDIA[1]

S. J. VENNISON AND DUNSTON P. AMBROSE[2]

(*With fifteen text-figures*)

Distant (1902 & 1910) in his fauna of British India described 41 species of *Acanthaspis*. In the present paper two new species of *Acanthaspis*, viz., *A. philomanmariae* and *A. livingstonei* are described and illustrated.

KEY FOR THE IDENTIFICATION OF INDIAN SPECIES OF GENUS *Acanthaspis*:

1. First joint of antennae passing apex of head 2
   First joint of antennae short, not passing apex of head 40
2. Posterior lobe of pronotum with two long discal spines 3
   Posterior lobe of pronotum without two long discal spines. 7
3. First and second joints of rostrum equal or subequal in length 4
   First joint of rostrum a little longer than second .... *A. subrufa* Distant
4. Legs not annulated, almost unicolourous 5
   Legs with dark annulation ... *A. sericata* Distant
5. Pronotal spines directed laterally .... *A. quinquespinosa* (Fabricius)
   Pronotal spines directed backwards 6
6. Black and ochraceous, posterior pronotal lobe transversely rugulose .... *A. bombayensis* Distant
   Dull reddish and piceous posterior pronotal lobe finely granulate .... *A. xeramplinia* Distant
7. Posterior lobe of pronotum with two or three short but prominent discal tubercles 8
   Posterior lobe of pronotum discally unarmed 21
8. Pronotum with three discal tubercles .... *A. philomanmariae* sp. nov.
   Pronotum with two discal tubercles 9
9. Pronotum unicolourous, unspotted 10
   Pronotum with anterior and posterior lobes differently coloured or palely marked 12
10. A spot behind each eye on side of ocelli, connexivum spotted, first joint of antennae about as long as head 11
    No spot behind the eyes, connexivum unicolourous, first joint of antennae little longer than head ....*A. bistillata* Stal.
11. First joint of rostrum distinctly longer than the second .... *A. fulvipes* Dall.
    First joint of rostrum shorter than the second .... *A. luteipes* Walk.

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[1] Accepted November 1986.

[2]Department of Zoology, St. Xavier's College, Palayankottai-627 002, Tamil Nadu, India.

12. Pronotum with anterior and posterior lobes differently coloured 13
Pronotum palely marked 15
13. Scutellar spine long and porrect .... *A. porrecta* Distant
Scutellar spine obliquely ascendant 14
14. Black and dull red .... *A. tavoyana* Distant
Ochraceous and fuscus .... *A. biligata* Walk.
15. Legs entirely or almost unicolourous 16
Legs not unicolourous 19
16. Legs piceous 17
Legs black .... *A. gulo* Stal.
17. Head distinctly sulcate between the eyes .... *A. vincta* Distant
Head not distinctly sulcate between the eyes .. 18
18. Pronotum disk not sulcate ....*A. flavipes* Stal.
Pronotum with the disk sulcate .... *A. angularis* Stal.
19. Apices of femora and tibiae palely coloured.. 20
Legs with dark annulations .... *A. zebraica* Distant
20. Pronotum lateral angles subspinously produced .... *A. helluo* Stal.
Pronotum lateral angles dentately produced .... *A. pernobilis* Reut.
21. Lateral angles of pronotum prominent, spinous or tubercular 22
Lateral angles of pronotum rounded, not prominent 39
22. Pronotum unicolourous unspotted 23
Pronotum not unicolourous 26
23. Legs unicolourous .... *A. rugulosa* Stal.
Legs not unicolourous 24
24. Femora and tibiae differently coloured .... *A. megaspila* Walk.
Femora and tibiae not differently coloured ... 25
25. Femora black, their apices and tibiae pale .... *A. apicata* Distant
Legs pale, femora darkly annulated .... *A. binghami* Distant
26. Pronotum with lateral angles palely coloured .... *A. succinea* Distant
Pronotum with anterior and posterior lobes differentially coloured or with spots or markings 27
27. Pronotum dark with pale markings or spots or anterior and posterior lobes differently coloured 28
Pronotum pale with dark spots and markings .... *A. inscripta* Distant
28. Pronotum with anterior and posterior lobes differently coloured 29
Pronotum with pale markings 32
29. Fuscus 30
Black 31
30. Obscurely fuscus .... *A. lineatipes* Reut.
Dilutely fuscus .... *A. fusconigra* Dohrn.
31. Scutellar spine obliquely erect .... *A. divisicollis* Walk.
Scutellar spine sub-reflexed .... *A. concinnula Stal.*
32. Legs unicolourous .... *A. trimaculata* Reut.
Legs not unicolourous 33
33. Corium fasciate .... *A. cinctricrus* Stal.
Corium spotted 34
34. First joint of antennae as long as head 35
First joint of antennae shorter than head 38
35. Scutellar spine almost horizontally erected .... *A. micrographa* Walk.
Scutellar spine obliquely ascendant 36
36. First joint of antennae darkly coloured than other joints .... *A. siva* Distant
First joint of antennae not darkly coloured than other joints 37
37. Black and luteous .... *A. rama* Distant
Piceous, fuscus, flavius and testaceous .... *A. sexguttata* Fabricius
38. First joint of rostrum little longer than the second .... *A. tergemina* Burm.
First and second joints of rostrum about equal in length .... *A. pustulata* Stal.
39. Niger or nigropiceous, scutellar spine not straight 40
Brownish ochraceous, scutellar spine straight .... *A. livingstonei* sp. nov.
40. Nigropiceous scutellar spine recurved, not resembling *Coranus* .... *A. annulicornis* Stal.
Black scutellar spine not recurved, resembling *Coranus* .... *A. coranodes* Stal.
41. Antennae four-jointed 42
Antennae five-jointed ......*A. unifasciata* Wolff.
42. Micropterus .... *A. pedestris* Stal.
Alate .... *A. biguttula* Stal.

I. **Acanthaspis philomanmariae** sp. nov.

MALE: Length: entire 6.55 mm; width across the eyes 0.47 mm and across the prothorax 1.9 mm (Fig. I, 1). Overall colour brownish, apex of head and entire legs and antennae brownish ochraceous, markings on the prothorax, two pairs of elongate oval spots in the claval and sub-claval region and membrane dark spots in the connexivum, venter of thorax and the bands in the femur dark brownish, integument polished, strongly pilose.

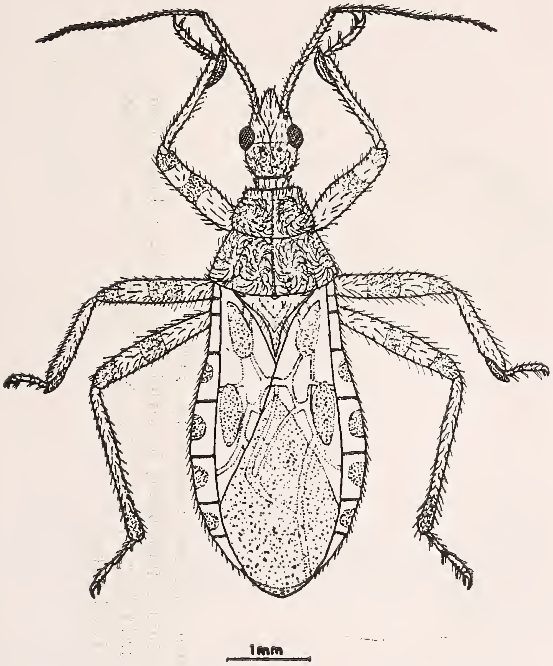


Fig. I. 1. *Aconthaspis philomanmariae* sp. nov. male.

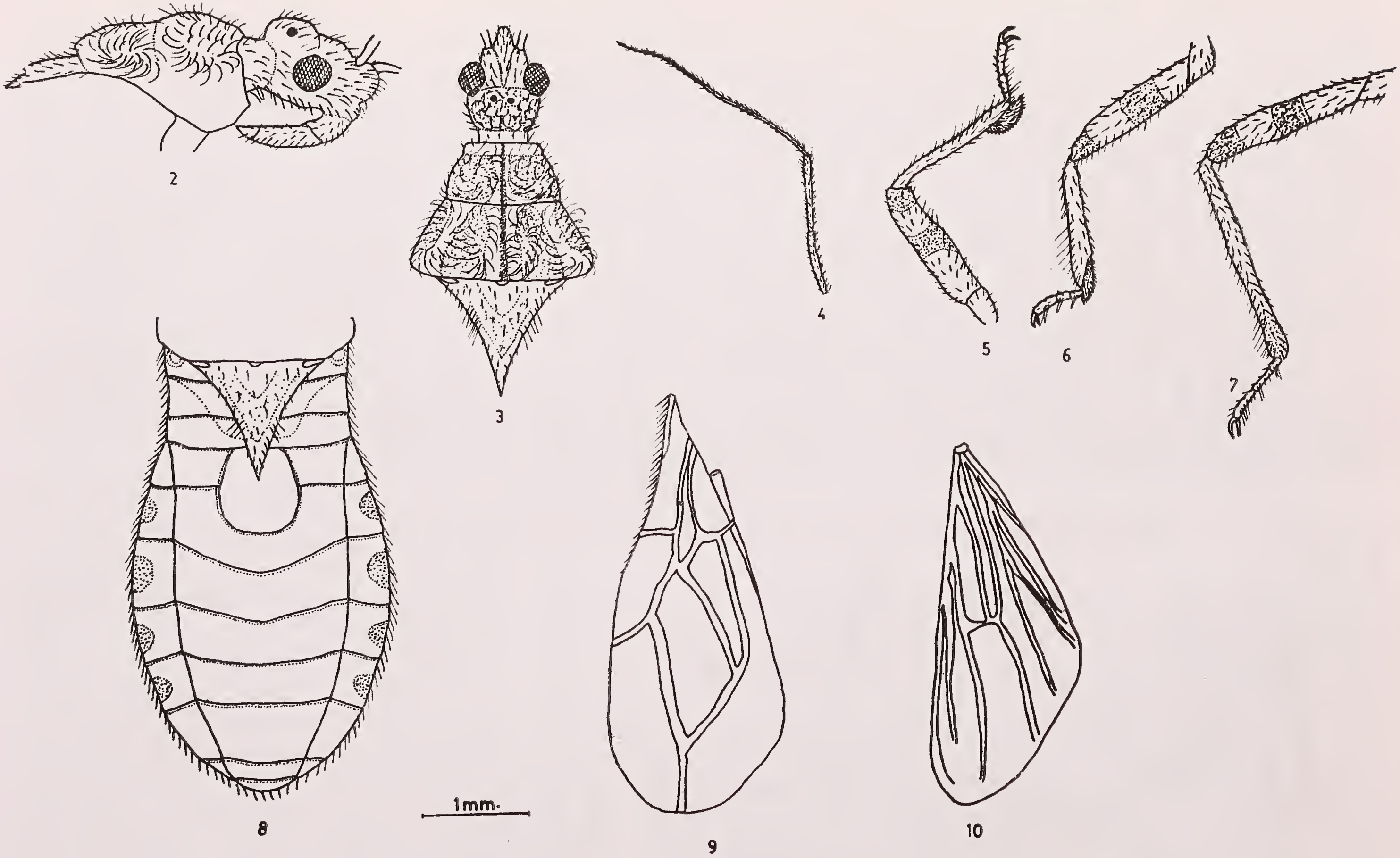
Head 1.13 mm long, strongly pilose; paler anteocular region (0.53 mm long) is separated from the darker postocular region (0.6 mm long) by black, laterally protruding compound eyes (0.2 mm diameter); two brown glassy ocelli, distance between ocelli greater than width of ocellus; anteocular region has prominent clypeal marking, 2 antenniferous tubercles — one at the base of each antenna, postocular region more rugose (Figs. I, 2 & 3). 4-segmented antennae (3.14 mm long) inserted frontally; scape shortest (0.5 mm long), elongate, stout, outwardly deflexed and extends beyond the apex of head, pedicel (0.62 mm long) slightly longer than scape; flagellar segments filiform; first flagellar segment the longest (1.05 mm); second flagellar segment (0.9 mm) longer than pedicel (Fig. I, 4); rostrum stout (1.08 mm long) and richly pilose, first (0.45 mm) and second (0.42 mm) joints subequal in length; third very small (0.2 mm); first segment strongly curved; second segment almost straight (Fig. I, 2).

Length of pronotum 1.56 mm; broader (1.9 mm) than long; lateral margins of anterior and posterior lobes forming slight angle, short anterior and long posterior lobes are separated by a well developed transverse sulcus (Fig. I, 3); 2 lateral suboval spots in the anterior lobe and 4 lateral elongately oval spots in the posterior lobe brownish ochraceous; posterior lobe with 2 lateral and 1 median, short but prominent tubercles; pronotum divided longitudinally by a median sulcus; scutellum triangular without any lateral process and faintly rugose anteriorly; apex projecting but not truly spinose (Fig. I, 8), legs richly pilose (Fig. I, 5-7) fore- (3.66 mm long) and mid-legs (3.53 mm long) almost equal in length; hind leg the longest (5.03 mm); fore- and mid-tibiae with short fossula spongiosae projecting beyond the tibial ends (0.34 mm and 0.3 mm long respectively); tarsi three-segmented; first segment very short, third segment as long as first and second combines.

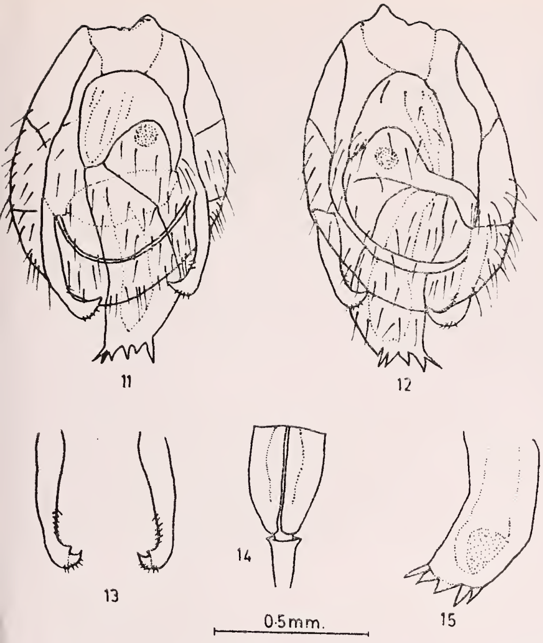
Hemelytra (3.8 mm long and 2.07 mm broad) extends slightly beyond the apex of abdomen with distinct venation on corium and membrane; venation of hemelytra and hindwings as in figure I, 9 & 10.

Abdomen longer (3.7 mm long and 2.49 mm broad) polished (Fig. I, 8), laterally richly pilose, ventrally convex, connexivum narrow with four dark brownish spots, connexivum devoid of spines. Genitalia as in Fig. I, 11-15.

Female has longer anteocular (0.58 mm) and postocular areas (0.62 mm), distance



Acanthaspis philomanmariae sp. nov.
Fig. I. 2-10: 2. Head, and pronotum, lateral view; 3. Head and pronotum dorsal view; 4. Antenna; 5. Fore leg; 6. Mid leg; 7. Hind leg; 8. Abdomen dorsal surface; 9. Hemelytron; 10. Hind wing.



Acanthaspis philomanmariae sp. nov.
Fig. I. 11-15: 11. Upper surface of Pygophore, with parameres; 12. Ventral surface of pygophore, with parameres; 13. Parameres; 14. Phallus; 15. Struts.

between eyes (0.52 mm), antennae (3.57 mm), fore, mid and hind legs (3.74, 3.74 and 5.63 mm respectively), abdomen (4.55 mm) and hemelytra (3.98 mm) than the male.

TYPE INFORMATION:

Holotype: Male, collected from Keeripparai, a rubber plantation in Kanyakumari District of Tamil Nadu on 30.05.1986. Allotype — Female, data same as the holotype, both are pinned and deposited in the Department of Zoology, St. Xavier's College, Palayankottai, India. Paratypes (several) collected from the same locality.

A. philomanmariae sp. nov. is closer to *A. bistillata* Stal., *A. fulvipes* Dall and *A. luteipes* Walk. in having the posterior pronotal lobe with discal tubercles but not two long discal spines. But *A. philomanmariae* with three pronotal discal tubercles can be easily distinguished from these species with two pronotal tubercles.

Etymology: This species is named after the parents (Philoman & Mary) of one of us (DPA).

Acanthaspis livingstonei sp. nov.

The present species compares well with the description given for the genus *Acanthaspis* and is described as new to science under the name *A. livingstonei.*

MALE: Length: entire 8 mm; width across the eyes 0.47 mm and across prothorax 2.32 mm. (Fig. II, 1).

Overall colour light brownish ochraceous, flagellar segments of antennae and annulations on the femora dark brownish; hemelytra black with anterolateral and median sanguineous spots on the corium; integument polished, strongly pilose.

Head 1.21 mm long, strongly pilose, subglobose; declivous anteocular portion (0.47 mm) shorter than darker postocular portion (0.74 mm); compound eyes (0.23 mm diameter) slightly protruding transversely, two prominent oval shaped, brown, glassy ocelli occupying just behind the eyes, deep sulcus in the synthlipsis; Y-shaped sulcus in the anteocular portion prominent; a central sulcus divides the clypeus; an antenniferous tubercle just above the compound eyes prominent; four-segmented antennae (4.52 mm long) inserted frontally; slightly outwardly deflexed scape stout, shortest (0.66 mm) and extends beyond the head; pedicel linear (0.98 mm) and the flagellar segments filiform, first flagellar segment (1.58 mm) longer than the second flagellar segment (1.31 mm) (Fig. II, 4) rostrum stout (1.22 mm long), scarcely pilose; slightly distant from gula; slightly curved first (0.44 mm long) and straight second (0.56 mm long) segments subequal in length; third

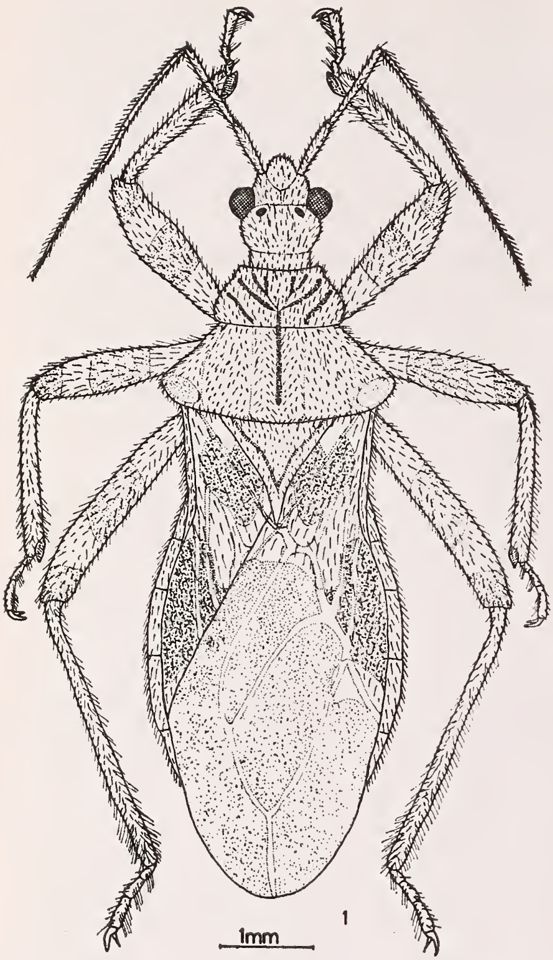


Fig. II. 1. *Acanthaspis livingstonei* sp. nov. male.

segment shortest (0.22 mm); there is a distinct neck (Fig. II, 2).

Length of pronotum 1.68 mm; broader (2.32 mm) than long; lateral margins of anterior and posterior lobes rounded, not prominent; pronotum constricted before middle by a transverse sulcus (Fig. II, 3); elevated anterior lobe with irregular sculpturations; posterior lobe slightly rugulose; pronotum longitudinally divided by a deep sulcus which is evanescent before the posterior end; richly pilose; posterolateral ends of pronotum with a depression on each side; scutellum triangular; its disc excavate without any lateral process; the posterior process well developed and spiniform; pilose (Fig. II, 8).

Legs strongly pilose, fore legs shortest and hind legs longest (fore, mid and hind legs 4.69, 3.34 and 11.18 mm respectively) (Fig. II, 5-7), infuscate; anterior femora slightly swollen; fore- and mid-tibiae with terminal spongy fossula; tarsi three-segmented; the first segment shortest, the third segment longest; ending with claws.

Hemelytra (5.13 mm long and 2.54 mm broad) extending considerably beyond the apex of abdomen; with concolourous venation distinct on corium and membrane (Fig. II, 9 & 10); corium slightly pilose, membrane polished.

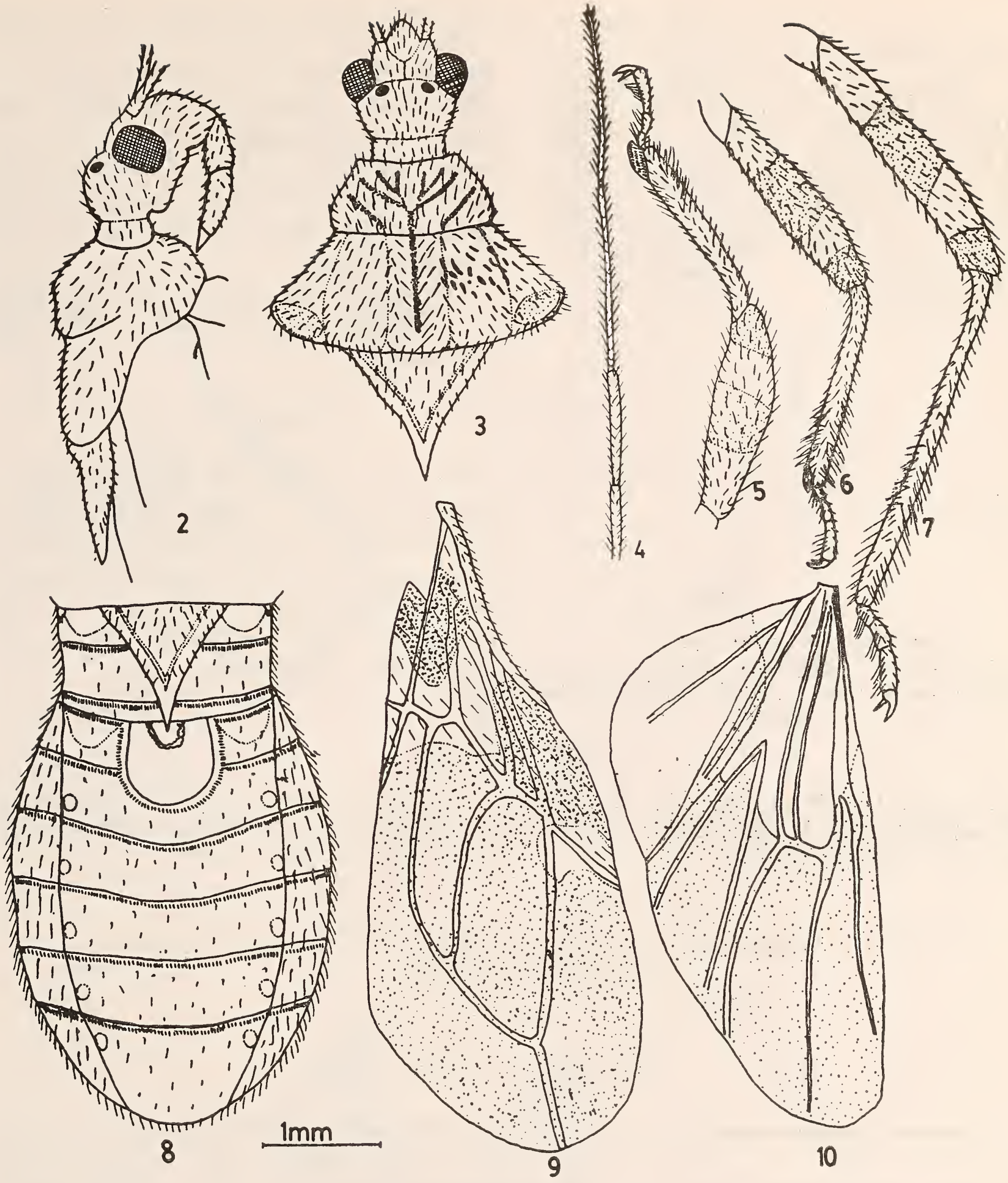
Abdomen elongately oval (4.7 mm long and 2.9 mm broad); laterally strongly pilose; centrally slightly pilose; connexivum unspotted; venter of abdomen convex (Fig. II, 8); genitalia as in fig. II, 11-15.

Female has longer anteocular area (0.49 mm), shorter postocular area (0.72 mm), longer distance between eyes (0.57 mm), antennae (4.76 mm), rostrum (1.26 mm), pronotum (1.84 mm), fore, mid and hind legs (4.64, 4.64 and 6.67 mm respectively), fossula spongiosae (0.46 & 0.24 mm), abdomen (5.61 mm) and hemelytra (5.66 mm) than the male.

TYPE INFORMATION:

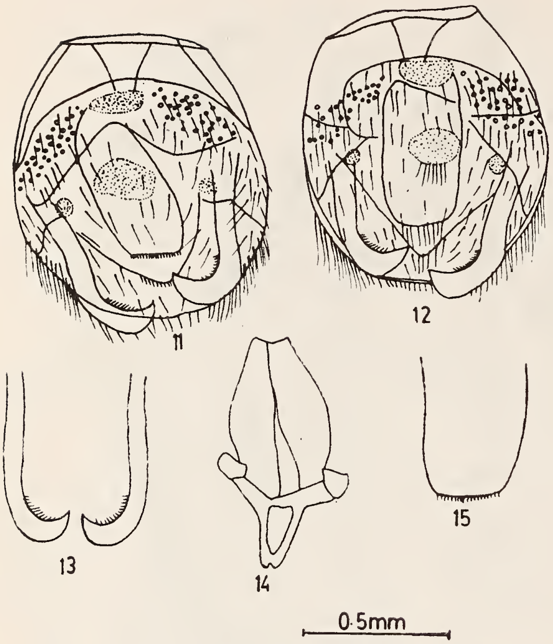
Holotype: ♂, collected from Thekkady tropical rain forest in Madurai district of Tamil Nadu on 14.06.1986. Allotype ♀ data same as the holotype, both are pinned and deposited in the Department of Zoology, St. Xavier's College, Palayankottai, India. Paratypes (several) collected from the same locality.

A. livingstonei is closer to *A. annulicornis* Stal. and *A. coranodes* Stal. in having the following characters: (1) first joint of antennae passing apex of head, (2) posterior lobe of



Acanthaspis livingstonei sp. nov.

Fig. II. 2-10: 2. Head and pronotum, lateral aspect; 3. Head and pronotum, dorsal view; 4. Entire antenna; 5. Fore leg; 6. Mid leg; 7. Hind leg; 8. Abdomen, dorsal view; 9. Hemelytron; 10. Hind wing.



Acanthaspis livingstonei sp. nov.
Fig. II. 11-15: 11. Pygophore; dorsal view; 12. Pygophore, ventral view; 13. Parameres; 14. Phallus; 15. Struts.

pronotum discally unarmed, (3) lateral angles of pronotum round, not prominent, (4) pronotum unicolourous and unspotted and (5) legs pale, femora darkly annulated. But *A. livingstonei* can be identified from *A. annulicornis* and *A. coranodes* in having unspotted connexivum, tibiae devoid of annulation, sanguineus spots on the black hemelytra and straight scutellar spine.

Etymology: This species is named in honour of our teacher and entomologist Dr. David Livingstone.

ACKNOWLEDGEMENTS

We are grateful to the authorities of Zoological Survey of India, for their help in determining the status of these materials and to the authorities of St. Xavier's College for facilities. The financial assistance of CSIR (Grant No. 513/(84)/EMR-II) for this work is gratefully acknowledged.

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———— (1910): The fauna of British India, Rhynchota. Vol. V (Heteroptera, Appendix). Taylor & Francis Ltd., London: 193-194.

A NEW SPECIES OF *CONNARUS* LINN. (CONNARACEAE) FROM PENINSULAR INDIA[1]

K. RAMAMURTHY AND R. RAJAN[2]

(*With nine text-figures*)

Connarus parameswaranii sp. nov.

Connarus sclerocarpus (Wight & Arn.) Schellenb. affinis, sed foliolis ovato-lanceolatis, opicibus abrupte acuminatis, nervis supra indistinctis, costis brunneo — pubescentibus; paniculis stellato - pubescentibus, velutinis; petalis glabris, folliculis ellipsoideis, minute rostratis, brunneo-tomentosis praecipue differt.

Connarus parameswaranii sp. nov. Allied to *Connarus sclerocarpus* (Wight & Arn.) Schel-

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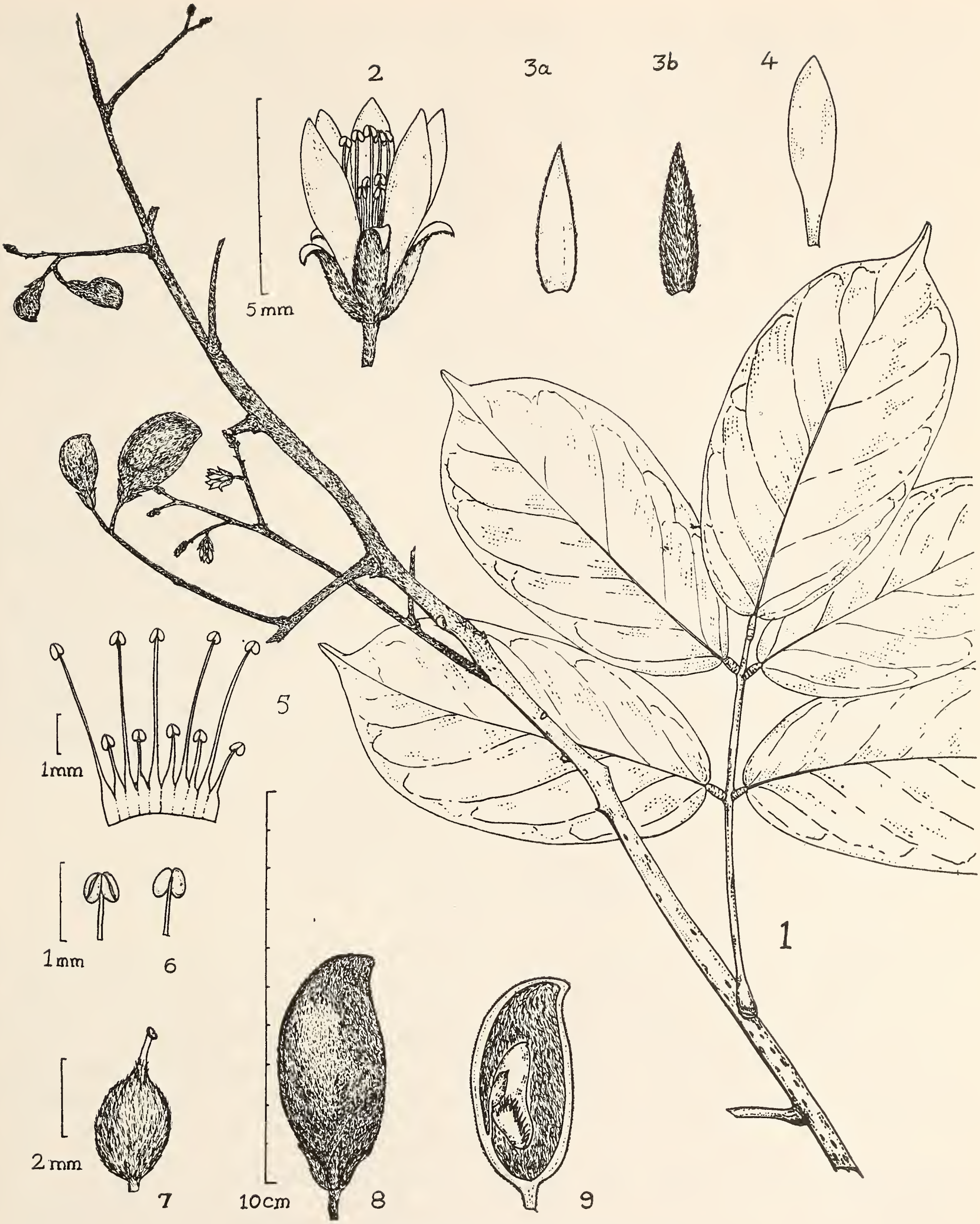
[1] Accepted May 1987.

[2] Botanical Survey of India, Southern Circle, Coimbatore 641 003, Tamil Nadu.


2
3a
3b
4
5 mm
5
1mm
1mm
6
2 mm
7
10cm
8
9
1

Figs. 1-9. *Connarus parameswaranii* sp. nov.
1. Flowering branch; 2. Flower; 3a. Sepal within; 3b. Sepal without; 4. Petal; 5. Staminal tube cut open; 6. Stamen; 7. Pistil; 8. Fruit; 9. Fruit L. S.

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lenb., but differs chiefly in: leaflets ovate-obovate, apex abruptly acuminate, nerves not distinct above, brownish hairy at midrib only; panicles stellate pubescent, velvety; petals glabrous and follicles ellipsoid, minutely beaked, brownish tomentose.

Liana; branches spreading, innovations densely stellate-plumose, brownish, velvety, old branches greyish, warted, lenticels present. Leaves imparipinnate, 1-2 pairs; rachis 5-13 cm long, brownish velvety. Leaflets 4-14 × 3-7 cm, ovate to obovate, coriaceous, leathery, apex abruptly acuminate, base rounded, rarely narrow; nerves 4-7 pairs, ascending from the main nerve jointed near the margin, inconspicuous above, distinct below, midrib brownish hairy; petiolules 3-4 mm long, thick, warty, dense tomentose. Panicles 16.5 cm long, terminal, brownish, velvety with numerous flowers. Flowers bisexual; bracts subulate, lanceolate, densely pubescent without, glabrous within. Sepals 5, each 4-5 × 1-2 mm, connate at base, persistent in fruit. Petals 5, each 4-5 × 1-2 mm, oblong, glabrous. Stamens 10, connate at base, epipetalous; filaments short. Pistil 1; ovary hairy; style slender; stigma capitate. Follicles immature 1-2.5 × 0.3-1.5 cm ellipsoid, oblique, inflated, stipitate, beaked, brownish tomentose pubescent within, suture curved on ventral side, straight on dorsal side; seed solitary, arillate at base.

Holotype *Ramamurthy* 66582 (CAL) and isotypes *Ramamurthy* 66582 (Acc. No. 138699-138700 MH) were collected at Adimali Reserve Forest, Idukki District, Kerala, India at an altitude of 1800 m on 29.3.1980.

The specific name is given in honour of Dr. M. Parameswaran Nayar, Director, Botanical Survey of India, Calcutta for his valuable contribution to Indian botany.

ACKNOWLEDGEMENTS

We wish to express our thanks to Dr. K. Thothathri, Joint Director, Botanical Survey of India, Calcutta for his valuable comments on this taxon. Our thanks are also due to Dr. N. P. Balakrishnan, Scientist 'D' and Dr. A. N. Henry, Scientist 'C' for their valuable suggestions, Dr. V. J. Nair, Scientist 'B' for Latin diagnosis, and to the Director, Botanical Survey of India for his constant encouragement during this investigation.

ADDITIONS TO THE GENUS *ALYSICARPUS* NECK. EX DESV.[1]

S. M. ALMEIDA[2] AND M. R. ALMEIDA[3]

(*With six text-figures*)

The Leguminous genus *Alysicarpus* Neck. ex Desv. is reported to have 45 species in all, out of which, according to Santapau & Henry (1973) 15 occur in India. While examining the material belonging to this genus deposited in Blatter Herbarium, we discovered that quite a few of the materials did not match with the earlier identified specimens. After critical examination, we have segregated the entire collection into 25 species and intraspecific taxa. We wish to present in this communication, some of the new taxa which we have segregated during the course of our study.

1. **Alysicarpus misquitei** sp. nov.

Externa facie *A. roxburghiano* plus minusve similis. Sed characteribus sequentibus differt:

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[1] Accepted March 1988.

[2] Blatter Herbarium, St. Xavier's College, Bombay-400 001.

[3] Alchemie Research Centre, Thane-400 601.

A. misquitei	*A. roxburghianus*
1. Omnia folia linearia-oblonga.	1. Omnia folia linearia.
2. Folia marginibus, reticulo et subter duabus lateribus costae hirsuta.	2. Glabra vel six hirsuta.
3. Axis inflorescentiae planus, fuscus, brevibus pilis fuscis prominentibus testis.	3. Rotundus, striatus, incoloratus, glaber.
4. Flores ex collo elevato rhachidis orientes, omnino alternantes; collum rigide hirsutum.	4. Flores ex collo elevato rhachidis non orientes; basales alternantes; apicales sessile et superpositae.
5. Bracteae dense hirsutae.	5. Glabrae.
6. Legumina dense pilosa, leviter reticulato-venosa, calyx 1-2 segmenta basalia leguminum tectans.	6. Glabra, avenia, solo segmento apicali exserto.
7. Legumina in pedicello nigro prominenti 0.3-0.4 cm longo elevata.	7. Legumina decrescentia base sicut brevi pedicello triangulo; 0.1 cm longo infuscato.

Holotypus: L. J. Sedgwick — Hubli 5282 (Sept. 1919) (BLAT).

Alysicarpus misquitei sp. nov. (Fig. 1)

An erect, branched herb up to 50 cm tall. Stems cylindric, slender, striate, with few scattered, deciduous hairs. Leaves simple, alternate, linear-oblong, 2.5-3 cm long, up to 0.5 cm broad, entire, hairy on the margins, acute at apex, rounded at base, petiolate. Petioles upto 0.5 cm long, grooved on the upper surface, rounded on the lower surface, narrowly winged on both sides, hairy at the junction of the lamina. Mid-vein prominent on the lower surface, hairy on both sides; lateral veins about 10, running towards the apex, joined with cross nervules, hairy; hairs scattered all over in the reticulum on the under surface. Stipels 2, linear, glabrous. Stipules 2, subulate, 1-1.5 cm long, about 0.5 cm broad at base, appressed to the stem, acuminate, many nerved from the base, glabrous. Inflorescence terminal, many flowered raceme. Rachis unbranched, erect, narrowing to the apex, pubescent all over with brown hairs; hairs appressed to the rachis. Flowers distant, alternate, in pairs, bracteate, stalked; stalks equal, about 0.3 cm long, stout, hairy all over; hairs brown. Bracts deciduous, subulate, 1.5-2 cm long, broad at base, narrowing to the apex in a long acumen, densely velvety tomentose beneath, many-nerved, glabrous within. Calyx tubular, acute at the base, persistent, covering 1/3 length of the pod. Sepals 5, free, linear-lanceolate, persistent, 1-1.2 cm long, 0.2-0.3 cm broad, acute at base, narrowing to the apex to a long acumen, many-nerved, sharply hairy on the dorsal surface, on the margins and at the apex. Corolla lobes 5, exserted, Standard ovate-oblong, narrowing to a short point at the base, broad at the apex, transparent, reticulately veined, glabrous. Wings 1.5-2 cm long. Keels adhering to the wings, transparent, clawed, glabrous, reticulately veined, Staminal tube 1.5-2 cm long, about 0.2 cm broad, transparent, striate. Stamens in two bundles, nine united and one free. Of the bundle of nine united stamens, 4 stamens are with filaments up to 1.5 cm long, the remaining stamens with filaments up to 1 cm long; free stamen up to 1.5 cm long; anthers 2-celled, dorsifixed, linear-oblong. Ovary oblong, flattened, about 1.5 cm long, about 0.5 cm broad, narrowing at both ends, appressedly hairy; style 1-1.5 cm long, brown, thick, slightly twisted at the base; stigma prominent, capitate, raised. Pod oblong, 2-3 cm long, raised on brownish-black slender stalk, turgid, 3-6 segmented; segments easily breaking up into individual compartments, rugose, with short appressed hairs, faintly reticulately veined, apiculate; apical segment with capular, erect, solid prolongation. Seeds solitary in each segment, reniform, blackish-brown, about 0.2 cm broad, with very faint tubercles on the testa.

Holotype: L. J. Sedgwick — Hubli 5282 (Sept. 1919) (BLAT).

Alysicarpus misquitei is more or less similar to *Alysicarpus roxburghianus* Thoth. & Pramanik in external appearance. But it can be distinguished from *A. roxburghianus* in the following characters:

	A. misquitei	*A. roxburghianus*
1.	Leaves linear-oblong.	Leaves linear.
2.	Leaves hairy on the margins, on the reticulum and on both the sides of the midrib underneath.	Leaves almost glabrous or with few scattered hairs.
3.	Inflorescence axis flat, dark brown, pubescent with prominent short brown hairs all over.	Inflorescence axis rounded, striate, not coloured, not hairy.
4.	Flowers arising from a raised collar on the rachis, alternate throughout; collar with number of stiff hairs.	Flowers not arising from a distinctly raised collar; basal flowers alternate, apical flowers sessile and arranged one above the other.
5.	Bracts densely hairy.	Bracts glabrous.
6.	Pods thickly, appressedly hairy, faintly reticulately veined, calyx covering only the basal 1-2 segments.	Pods glabrous, not veined, only the apical segment is exserted.
7.	Pod raised on a prominent black stalk about 0.3-0.4 cm long.	Pod narrowing at the base to a triangular short stalk; stalk about 0.1 cm long, not dark coloured.

This species is named after Rev. Fr. John Misquitta, S.J., the Principal of St. Xavier's College, Bombay, for his deep enthusiasm and dedication in the development and promotion of research activities in various departments of the college.

2. **Alysicarpus narimanii** sp. nov.

Externa facie *A. heyneano* Wight & Arnott plus minusve similis sed sequentibus characteribus differt:

	A. narimanii		*A. heyneanus*
1.	Folia ovata ad linearia-oblonga, breviter mucronata apice.	1.	Obovatus mucronulatus apice.
2.	Flores remotae dispositae.	2.	± Compactae dispositae.
3.	Sepali pilis flavis, permanentibus, bulbosis basibus vestiti.	3.	Glabres vel sparsim deciduae pilosae.
4.	Sepali acuminati apice, legumine integra fere tegentes.	4.	Sepali acuti apice, legumina exposita, pauca segmenta basalia tantum tegentia calyce.
5.	Legumina investricta reticulato-venosa; segmento apicali leguminis cum prolongatione triangulo, non-reticulato.	5.	Legumina profunde constricta; transversa prominente forte costata; segmentum apicale cum prolongatione brevi costata.

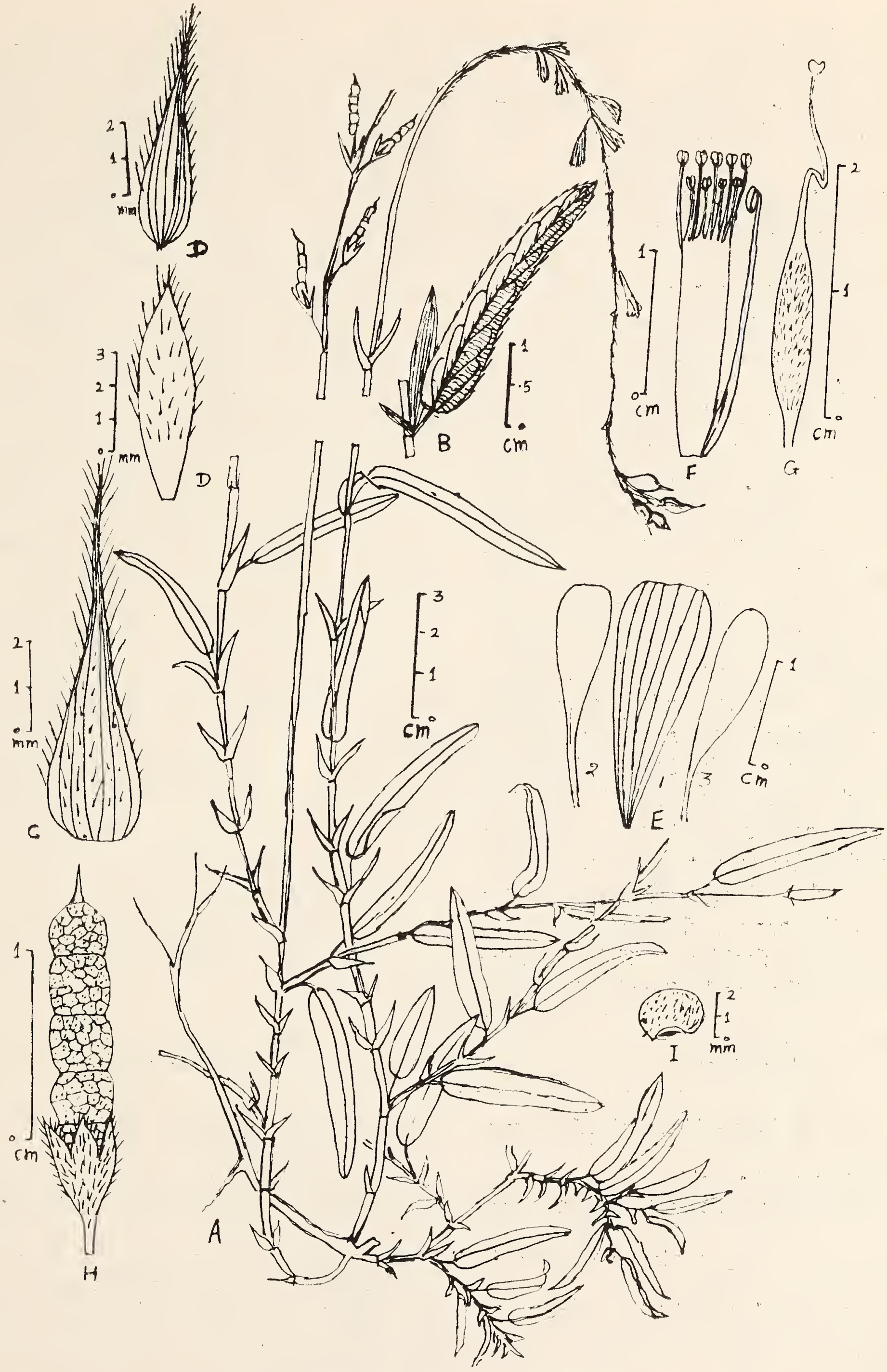
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Fig. 1. *Alysicarpus misquitei* sp. nov.
A. Flowering & Fruiting Plant — Habit; B. An internode showing a single pinna with stipel and stipule; C. Bract; D. Sepals; E. Petals — 1. Standard, 2. Wing, 3. Keel; F. Androecium; G. Gynoecium; H. Pod; I. Seed.

Holotypus: H. Santapau — Khandala — 2982(18.10.1943) (BLAT).

Paratypus: G. L. Shah — Trombay — 10593 (22.9.1962) (BLAT).

Alysicarpus narimanii sp. nov. (Fig. 2)

An erect to decumbent, slender, branched herb, 50-90 cm tall. Stem striate, with 2 prominent ribs, hairy. Leaves alternate, varying in size and shape, ovate to linear-oblong, 2-3 cm long, 0.5-0.8 cm broad, entire, rounded at base, shortly mucronate at the apex, hairy on the margins and on both the sides of the mid-vein underneath, reticulately veined, shortly petioled. Petiole slender, about 0.5 cm long, with few, short, scattered, brown hairs at the junction of the lamina, stipulate. Stipules linear-lanceolate, 2-2.5 cm long, acuminate, with many parallel nerves. Inflorescence axillary and terminal racemes. Rachis slender, striate, almost glabrous or with few scattered hairs. Flowers dark-straw coloured, shining, binate on equal sized stalks arising from a raised joint on the rachis. Stalks about 0.2 cm long, slender, with few brown hairs, bracteate. Bracts broadly ovate, 0.5-0.7 cm long, 0.2 cm broad, hairy on the margins, rounded at base, narrowing abruptly from both the sides towards the apex and terminating in a long erect acumen, deciduous. Calyx tubular almost covering the pod. Sepals 5, linear-oblong, 0.5-0.7 cm long, 0.1 cm broad, narrowing to the base into a short stalk, terminating in a long acumen at the apex; hairs yellow, erect. Outer sepals slightly broader and with longer claws than the rest of the sepals, many nerved. Corolla membranous, veined, clawed, brittle. Wings and keels almost fused in dry materials and difficult to segregate. Staminal tube about 1-1.5 cm long, shorter than the corolla. Stamens in two bundles, nine united and one free. Out of the 9 united stamens four stamens with longer filaments alternate with the five shorter ones. Pods 3-3.5 cm long, 4-6 segmented; segments easily separating into individual compartments, reticulately veined, flat, compressed, sometimes quadrangular. Apical segment with capular prolongation, without any reticulations and bears a thick style with a prominent stigma; basal segments narrowing to the stalk. Stalk 3-3.5 cm long, yellow, softly hairy. Seeds rounded, brown, compressed, smooth, solitary in each segment.

Holotype: H. Santapau — Khandala 2982 (18.10.1943) (BLAT).

Paratype: G. L. Shah — Trombay — 10593 (22.9.1962) (BLAT).

Alysicarpus narimanii is more or less similar to *A. heyneanus* Wight & Arnott in its external appearance but it differs from it in the following characters:

A. narimanii	*A. heyneanus*
1. Leaves ovate to linear-oblong, shortly mucronate at apex.	Leaves obovate, mucronulate at apex.
2. Flowers distant on the rachis.	Flowers more or less compact on the rachis.
3. Sepals with yellow, persistent, bulbous based hairs.	Sepals glabrous or with few scattered deciduous hairs.
4. Sepals acuminate at apex, almost covering the entire pod.	Sepals acute at apex, pods exposed, only the basal few segments are covered by the calyx.
5. Pods not constricted, reticulately veined; apical segment with a triangular prolongation without any reticulation.	Pods deeply constricted, all the segments with prominent strong transverse ribs, apical segment with short prolongation.

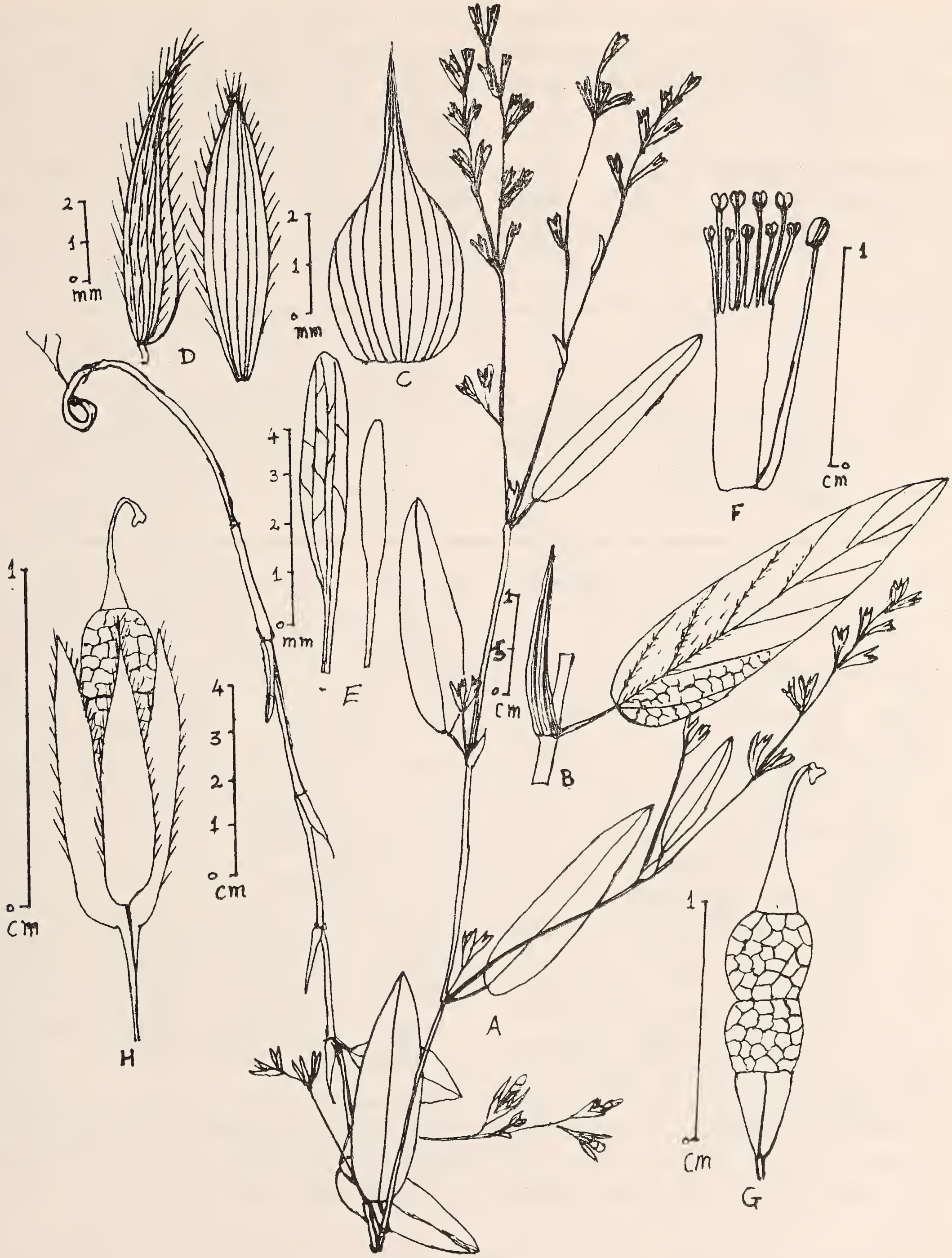
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Fig. 2. *Alysicarpus narimanii* sp. nov.
A. Flowering & Fruiting plant — Habit; B. Internode with leaf and stipule; C. Bract; D. Sepals; E. Petals; F. Androecium; G. Gynoecium; H. Pod.

The species is named after our colleague, late Dr. Nariman A. Irani, well known for his contribution to the taxonomic studies on the flora of Matheran.

3. **Alysicarpus sedgwickii** sp. nov.

Externa facie *A. ludens* (Wall. ex Baker) Backer similis sed differt sequentibus characteribus:

A. sedgwickii	*A. ludens*
1. Herbae graciles.	1. Herbae crassae.
2. Flores in racemis folia opposita dispositae.	2. In racemis terminalibus dispositae.
3. Legumina cylindrica fere aequabili magnitudine.	3. Non cylindrica, pyramidalia.
4. Segmenta leguminis reticula- to venosa cum pilis brevibus appressis brunneis.	4. Segmenta compressa, glabra, valde costata, cum costis horizontaliter parallelis.
5. Segmenta apicalia cum brevissima prolonga- short prolongation.	5. Segmenta apicalia cum crassa erecta prolongatione triangula.

Holotypus: L. J. Sedgwick — Nawabshah, Sindh — s.n. (Oct. 1923) (BLAT).

Alysicarpus sedgwickii sp. nov. (Fig. 3)

An erect, branched herb, 25-75 cm tall. Stem thick, faintly striate, with few scattered hairs. Leaves simple, alternate, linear-oblong, distant on the stem, 5-7 cm long, 0.5 cm broad, entire, acute at apex, narrowing to the base, reticulately veined. Mid-vein prominent on the lower surface, appressedly hairy on both the sides of the mid-vein; lateral veins faint, far apart, running towards the apex. Petiole up to 0.5 cm long, very slender, grooved in the centre, shortly hairy at the junction of the lamina. Stipule subulate, acuminate, 0.5-1 cm long, many-nerved, glabrous, not prominent. Inflorescence leaf-opposed raceme. Rachis slender, unbranched, becoming very thin towards the apex. Flowers very small, alternate, binate, distant on the rachis, stalked. Stalks slender, lightly coloured, hairy. Calyx linear, deeply cut, segments 0.5-0.7 cm long, clawed, softly hairy on the sides, shortly acuminate, many nerved, transparent and persistent. Corolla small, transparent, clawed, reticulate, about 0.8 cm long. Wings and keels, difficult to segregate in dry materials. Staminal tube 0.5 cm long, transparent. Stamens in two bundles, 9 united and 1 free; filaments very slender. Ovary 0.6-0.8 cm long, 0.1 cm broad, flat, cylindric, hairy all over, with very short brown hairs; style thick, curved from the middle; stigma raised, capitate. Pods cylindric, 1-2 cm long, 0.3-0.4 cm broad, 4-angled, jointed not contricted in between, 5-6 segmented, raised on a short stalk. Segments grooved, 0.1-0.2 cm long, 0.1 cm broad, rugose, with short hairs on both the sutures and surfaces, easily separating into individual compartments; lower segments partly covered by the persistent calyx lobes; apical segment with a small deciduous prolongation. Seeds reniform, brownish-black, solitary in each segment.

Holotype: L. J. Sedgwick-Nawabshah-Sindh s.n. (Oct. 1923) (BLAT).

Alysicarpus sedgwickii is similar to *A. ludens* (Wall. ex Baker) Backer in general appearance but it can be differentiated from *A. ludens* in the following characters:

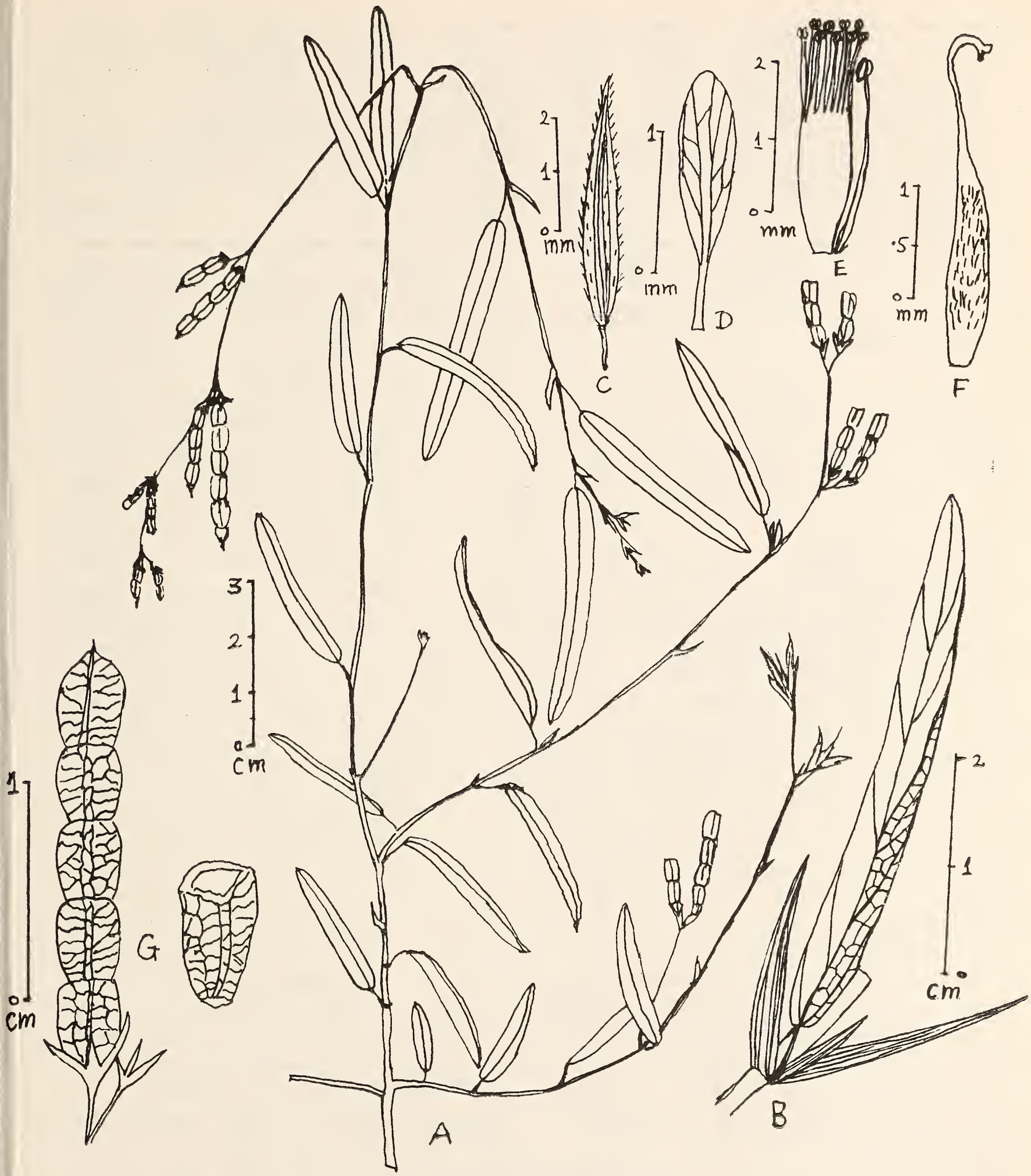
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Fig. 3. *Alysicarpus sedgwickii* sp. nov.
A. Flowering & Fruiting plant — Habit; B. Internode with leaf stipel & stipules; C. Calyx lobe; D. Standard petal; E. Androecium; F. Gynoecium; G. Pod — entire & a segment.

	A. sedgwickii	*A. ludens*
1.	Slender herbs.	Stout herbs.
2.	Inflorescence leaf-opposed.	Inflorescence terminal racemes.
3.	Pods cylindric, almost of uniform size.	Pods not cylindric, pyramidal in shape.
4.	Segments of the pod reticulately veined and with short appressed brown hairs.	Segments of the pod compressed, strongly ribbed, with horizontal ribs, not hairy.
5.	Apical segments with very short, slender prolongation.	Apical segments with thick, erect, triangular prolongation.

This species is named after L. J. Sedgwick for his contributions to the botany of erstwhile Bombay Presidency.

4. **Alysicarpus salim-alii** sp. nov. similis *Alysicarpo scarioso* (syn. *A. rugoso* DC. var. *styracifolia* Baker) externo aspectu, sed differt laxo racemo in quo flores remote dispositae sunt et folia post secata atro-caeruleus non evadunt.

Holotypus — Blatter 9376, Leni Hill —, Nasik District (Sept. 1917) (BLAT).

Isotypus — Blatter 10034, Leni Hill — Nasik District (Sept. 1917) (BLAT).

Alysicarpus salim-alii sp. nov. (Fig. 4)

An erect, branched tomentose herb, up to 50 cm tall. Stem with nodes and internodes, strigose, hairy. Hairs white, compact, microscopic in nature. Leaves simple, 1.6 cm × 4.2 cm, alternate oblong, obtuse at apex, rounded at base, hairy on both the surfaces, more hairy on the lower surface and towards the midrib, stipulate, shortly petioled. Petiole 0.3-0.4 cm long, densely hairy; hairs white, erect, bulbous based, more towards the junction of the petiole. Stipels 2, linear-oblong, striate, hairy. Stipules 2, 1-1.5 cm long, 0.3-0.4 cm broad at base, lanceolate, sheathing at base, striate, acuminate at apex. Inflorescence leaf opposed and terminal lax raceme. Rachis 3-11 cm long, densely hairy, brownish-black. Flowers binate on equal sized stalks; stalk about 0.6 cm long, sparsely hairy, bracteate. Bract 1-1.5 cm long, 0.4-0.5 cm broad at base, narrowing to the apex, striate with a prominent midrib ending in a long-acumen; acumen hairy on both the margins and at the apex. Calyx tube short; Sepals 5, outer 2 sepals oblong, about 1 cm long, 1-1.5 cm broad, striate, with a prominent mid rib, hairy at the apex; inner 3 sepals somewhat connate at base, clawed, striate, about 1 cm long, hairy and acute at apex. Petals 5; standard broadly ovate, 0.7-0.8 long, 0.2-0.3 cm broad, striate, glabrous, rounded at apex, narrowing to the base, glandular; glands 2, circular, one in the centre towards the apex and the other towards the margin slightly below the apex; wings membranous, 0.5-0.6 cm long, with slender claw. Keels adhering to the wings, 0.5-0.8 cm long, clawed. Staminal tube oblong, 0.5-0.8 cm long. Stamens in 2 bundles, 9 united and 1 free; of the 9 united stamens 5 stamens with long filaments, alternate with the 4 short stamens. Free stamen with long filament, as long as the staminal tube. Fruits 2-3 segmented, 0.8-1 cm long stalked, almost covered by the calyx; middle segments of the fruit ovoid, compressed, flat, rugose, with horizontal ribs; basal segment without any ribs, oblong, narrowing to the stalk; apical segment with prominent style which is triangular at base, narrowing to the apex, curved inwards, adhering to the middle of the standard petal; stigma capitate.

Holotype: Blatter-Leni Hill, Nasik District 9376, (Sept. 1917) (BLAT).

Isotype: Blatter-Leni Hill, Nasik District 10034, (Sept. 1917) (BLAT).

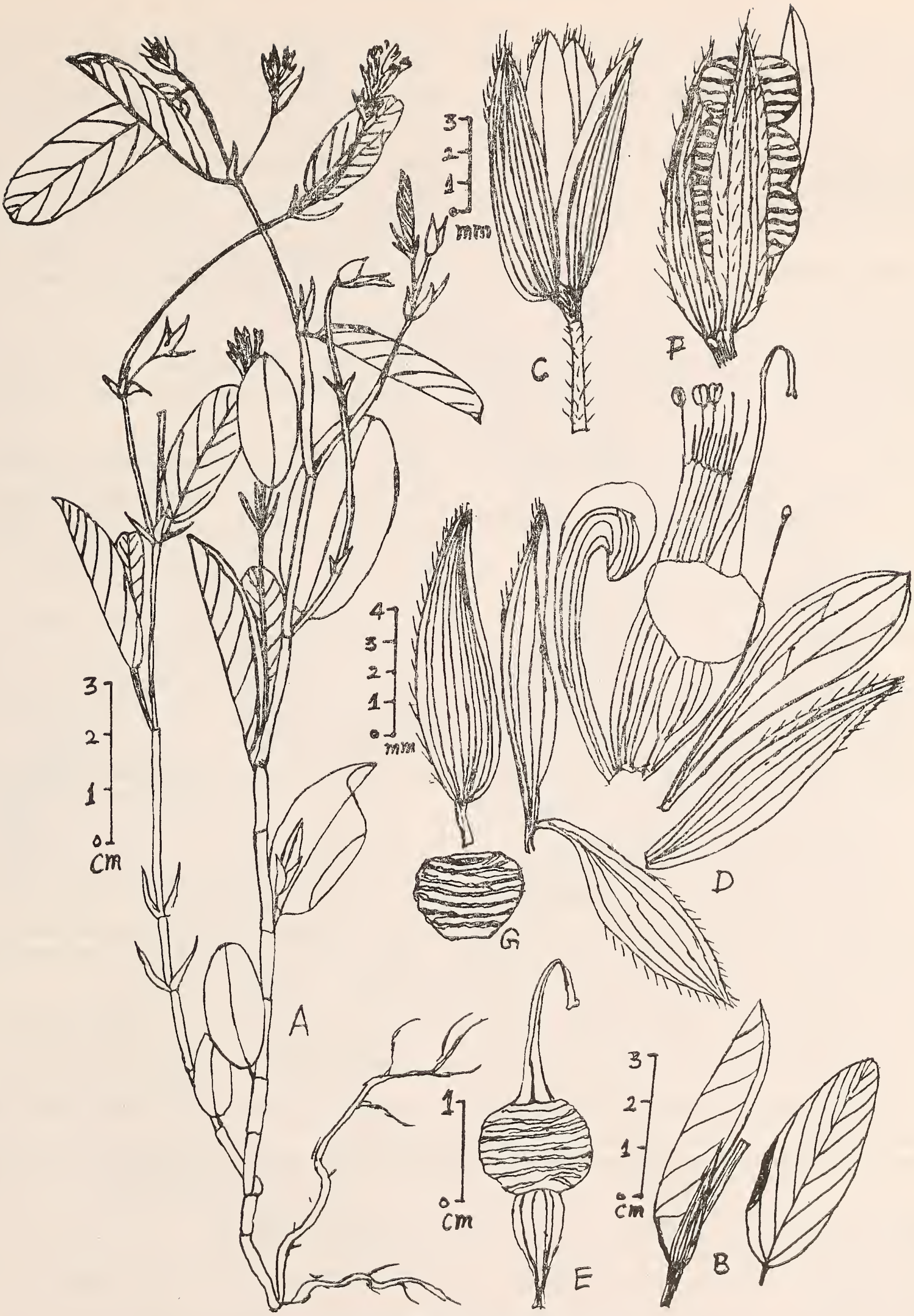

Fig. 4. *Alysicarpus salim-alii* sp. nov.
A. Flowering & Fruiting plant — Habit; B. Internode with leaf and stipule; C. Flower; D. Flower opened out showing the floral parts; E. Gynoecium; F. Pod with persistent sepals; G. A segment of the pod.

This species is named in memory of the renowned ornithologist, Dr. Salim Ali, for his dedication to the subject of conservation of nature.

5. **Alysicarpus monilifer** (Linn.) DC. var. **cuddapahensis** var. nov.

Varietate typica differt sequentibus characteribus:

var. *monilifer*	var. *cuddapahensis*
1. Folia oblonga ad linearia-lanceolate.	1. Ovata.
2. Legumina cum segmentis ovalibus, inflatis, facile separabilibus, mollibus, glabribus, dilute reticulato venosis.	2. Legumina cum segmentis rotundis, sulcatis, non facile separabilibus, crassis, dense pilosis scabribus.

Holotypus: S. K. Wagh — Cuddapah — 7768 (25-1-1958) (BLAT).

Isotypus: S. K. Wagh — Cuddapah — 7769 (25-1-1958) (BLAT).

Alysicarpus monilifer (Linn.) DC. var. **cuddapahensis** var. nov. (Fig. 5)

An erect branched herb up to 40 cm tall. Stem striate, with few scattered brown hairs. Apical branches more densely hairy. Leaves oblong-lanceolate, 2.5-5 cm long, 0.5-0.8 cm broad, acute at apex, rounded at base, strongly reticulately veined on the ventral surface, hairy on the nerves beneath, shortly petiolate and stipulate. Petiole about 0.8 cm long, striate. Stipules subulate, sheathing with a circular ring at the base, about 0.8 cm long and 0.2 cm broad at base, glabrous. Flowers alternate, binate, on distant raised collars on the rachis, bracteate. Bracts triangular, glabrous, about 0.6 cm long, 0.2 cm broad, striate, acuminate. Calyx small, about 0.2 cm long, lanceolate, with prominent mid-vein, glabrous, shortly acuminate. Fruits moniliform, 4-5 segmented, not constricted. Segments of pods oblong-round, softly reticulate, glabrous, almost fully exserted except the basal one segment which is partly covered by the persistent calyx-lobes.

Holotype: S. K. Wagh — Cuddapah — 7768 (25-1-1958) (BLAT).

Isotype: S. K. Wagh — Cuddapah — 7769 (25-1-1958) (BLAT).

Alysicarpus monilifer (L.) DC var. *cuddapahensis* differs from the typical variety in the following characters:

var. *monilifer*	var. *cuddapahensis*
1. Leaves oblong to linear-lanceolate.	Leaves ovate.
2. Pods with oval, inflated, easily detachable, soft, faintly reticulately veined glabrous segments.	Pods with rounded, grooved, not easily detachable, thick, densely puberulous, rough segments.

This variety is named after the type locality Cuddapah, Andhra Pradesh.

6. **Alysicarpus tetragonolobus** Edgew. var. **pashanensis** var. nov.

Varietate typica differt sequentibus characteribus:

var. *tetragonolobus*	var. *pashanensis*
1. Legumina distincte quadrangulata.	1. Non quadrangulata.
2. Tubus staminalis non striatus.	2. Striatus.
3. Tubus staminalis adhaerens vexillo habenti pannum luteum.	3. Non adhaerens vexillo, sine panno.
4. Sepali amplitudine variabili.	4. Sepali amplitudine uniformi.

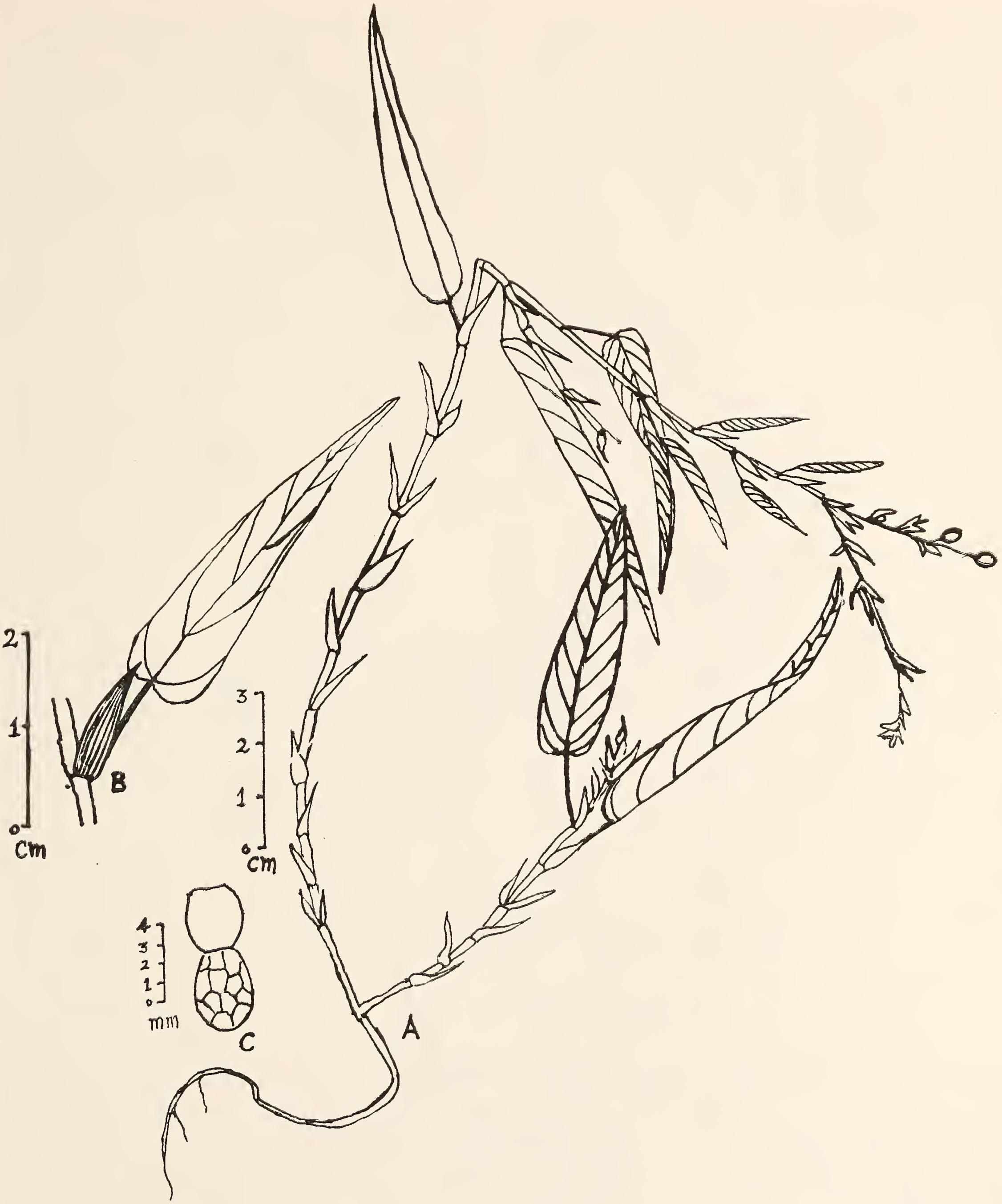
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Fig. 5. *Alysicarpus monilifer* DC. var. *cuddapahensis* var. nov.
A. Fruiting plant — Habit; B. Internode with leaf and stipule; C. Fruit.

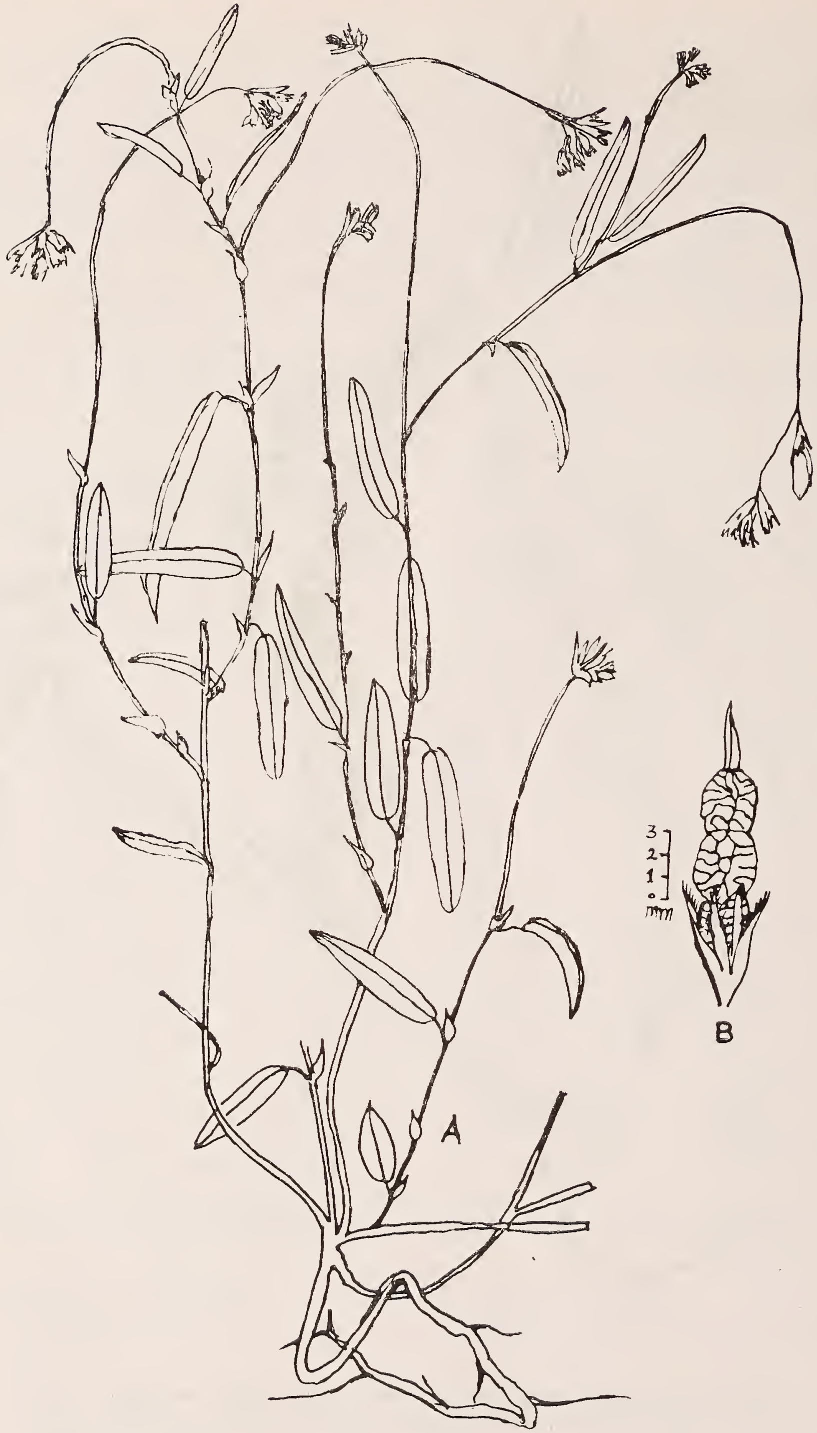

Fig. 6. *Alysicarpus tetragonolobus* Edgew. var. *pashanensis* var. nov.
A. Fruiting plant — Habit; B. Pod.

Holotypus: D. P. Panthaki — Pashan Lake, Poona — 2009 (12.11.1954) (BLAT).

Isotypus: D. P. Panthaki — Pashan Lake, Poona 2009 (12.11.1954) (BLAT).

Alysicarpus tetragonolobus Edgew. var. **pashanensis** var. nov. (Fig. 6)

An erect branched herb, 20-30 cm tall. Stems striate, angled, hairy on one side; hairs short, white, deciduous. Leaves simple, linear-oblong, 2.5-3.5 cm long, about 0.5 cm broad, alternate, acute at apex, rounded at base, softly hairy on margins, appressedly hairy on both the sides of the mid-vein underneath, punctate, coriaceous, shortly petioled. Petioles 0.2-0.3 cm long, hairy at the junction of the lamina, stipellate. Stipels small, linear. Stipules triangular, 0.5-0.7 cm long, about 0.2 cm broad at base, prominently striate, acuminate at apex, softly hairy on the margins; hairs deciduous. Inflorescence terminal racemes. Flowers few, deciduous, straw-coloured and shining, distant on the rachis, alternate at the base of the rachis, crowded towards the apex, arising from a distinct raised collar on the rachis, stalked, bracteate. Bracts triangular, 0.6-0.8 cm long, about 0.2 cm broad at base, striate, acuminate, deciduous. Rachis unbranched, softly hairy on one side. Stalk about 0.3 cm long, hairy on one side. Calyx tubular; sepals 5, clawed, about 0.5-0.7 cm long, hairy; hairs white, erect and crowded towards the apex. Standard broadly ovate, striate, yellow, about 0.8 cm long and 0.3 cm broad, membranous. Wings yellow, with a purple tinge on one side, clawed, about 0.6 cm long. Keels purple, clawed, transparent. Staminal tube about 0.5 cm long, 0.1 cm broad, yellowish-brown. Stamens in two bundles, nine united and one free. Out of the nine united stamens four are with longer filaments; free stamen with a flattened orange-yellow filament. Pistil raised on a short stalk; ovary oblong, about 0.1 cm long; style thick, orange-yellow, 0.4 cm long; stigma raised, clavate, yellow. Pods exserted, 3-5 segmented, narrowly constricted in between the segments; segments oblong, rough, with irregularly folded thick ribs, hard; apical segment with stout, glabrous, erect prolongation of about 0.2 cm long, basal segment covered by the persistent calyx.

Holotype: D. P. Panthaki — Pashan Lake, Poona 2009 (12-11-1954) (BLAT).

Isotype: D. P. Panthaki — Pashan Lake, Poona-2010 (12.11.1954) (BLAT).

The new variety differs from the typical variety in the following characters:

	var. *tetragonolobus*	var. *pashanensis*
1.	Pod distinctly 4-angled.	Pod not distinctly 4-angled.
2.	Staminal tube not striate.	Staminal tube striate.
3.	Staminal tube adhering to the standard; standard with a prominent yellow patch in the centre.	Staminal tube not adhering to the standard, standard without any coloured patch.
4.	Sepals varying in size.	Sepals of uniform size.

This variety is named after its type locality Pashan, near Poona.

We are grateful to Rev. Fr. Conrard Mascarenhas for rendering the Latin diagnosis, to Dr. (Mrs.) A. R. Daruwalla for the help rendered in preparing this paper, and to Mr. Rajendra Shinde for incidental verifications.

REVIEWS

1. INDIAN TURTLES A FIELD GUIDE. By Indraneil Das. pp. 119 (24.5 × 15 cm), with many illustrations. Calcutta, 1985. World Wildlife Fund-India, Eastern Region, Price Rs. 35/-.

Turtles and tortoises come very low in conservation priority compared to the glamorous mammals. This is unfortunate. These fascinating animals offer a silent service as scavengers but apart from such utilitarian considerations, turtles are a singularly interesting group, which, though insulated in a bony carapace, still have many enemies, particularly man to make 14 out of the 31 species or nearly 50% of the species occurring in India vulnerable or endangered.

In this fascinating field guide, Indraneil Das describes and illustrates the 31 species and subspecies of marine and fresh water turtles and the land tortoises which occur within the political area of **India.**

The Guide has been written as an introduction to those not familiar with turtles and tortoises. Beginning with the origin of turtles it gives brief descriptions of turtle structure, habits and habitats, breeding, predators both natural, and human, commercial exploitation and conservation requirements.

The second section starting with Chapter XII briefly and succinctly describes and illustrates, identification characters, distribution, habits and conservation status of the 31 species occurring in India.

A useful and recommended field guide.

J. C. DANIEL

2. MANGROVES IN INDIA: STATUS REPORT. Pp. i-vii + 150 (23.5 × 16 cm.) with 8 plates of coloured photographs. New Delhi, 1987. Published by the Government of India, Ministry of Environment & Forests. Price: Not indicated on the book.

The report deals in length with the available information on Indian mangroves published so far in the following chapters.

1. Introduction. 2. The importance of coastal vegetation. 3. Nature of mangrove environment. 4. Distribution of Indian mangroves. 5. Aspects of research. 6. Some case studies. 7. Economic assessment of mangroves and 8. Management perspectives.

Under chapter 4, namely distribution, the present status of Indian mangroves in Orissa, Andhra Pradesh, Tamil Nadu, Gujarat, Maharashtra, Goa, Karnataka and Kerala is given. However, information is far from complete, probably due to the dependance of the compiler of this volume on limited sources of information.

The coverage on mangroves of Maharashtra is very meagre and lacks realistic information. There is no mention of the scattered mangrove swamps which are at present located in Sindhudurg, Thane and Raigad districts.

The mangroves of Vengurla, Malvan, Deogad and Achra (Sindhudurg district) have been studied by Dr. B. G. Kulkarni of Botanical Survey of India (Pune), while mangroves of Aronda (Sindhudurg district), Ratnagiri, Dabhol and Rajapur (Ratnagiri District) have been taxonomically studied by Dr. (Mrs.) S. M. Almeida.

A number of typographical errors occur and good proof-reading would have certainly enhanced the value of the publication.

The Bibliography at the end of the Volume cites 189 national, as well as international references.

The publication also gives the names and addresses of the members of the reconstituted National Mangrove Committee. This Committee has nine members out of which three are secretaries of concerned Government departments!

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. TOXICITY OF BRODIFACOUM (LIQUID, PELLETS AND WAX CAKE) AGAINST *MERIONES HURRIANAE* AND *RATTUS RATTUS*

INTRODUCTION

Numerous chemical control methods have been extensively adopted throughout the world to get rid of rats. Zinc phosphide has been used since early 1940 with limited success because rats develop bait shyness and it is hazardous to non-target species. Brodifacoum, bromadiolone and warfarin are the new anticoagulant rodenticides. Warfarin is required in multiple dose for effective control. Brodifacoum and bromadiolone are the new potent anticoagulants that form a bridge between the fast acting and slow acting rodenticides (Jain 1980).

The present study has been conducted to evaluate efficacy of brodifacoum, a single dose potent anticoagulant against *R. rattus* and *M. hurrianae.*

MATERIAL AND METHODS

Laboratory feeding tests were conducted on individually caged *Rattus rattus* and *Meriones hurrianae.* All the animals were sexed, weighed and acclimatized to laboratory conditions prior to the experiments. Rat feed (Hindustan Lever Ltd., Bombay) and water was provided freely. The animals were weighed and starved for 24 hours. Poison bait of brodifacoum at 0.005 percent concentration was exposed to the individually caged animals in three forms, viz. liquid, cakes and pellets for 24 hours in no-choice feeding test. After 24 hours of poison baiting, fresh rat feed was provided daily until death. Liquid brodifacoum was exposed by diluting the poison with distilled water. Symptoms of poisoning were recorded.

RESULTS AND DISCUSSION

The results of the investigation, presented in table 1, indicate that all the three forms of brodifacoum killed the rats in a reasonable period. The mortality of the rats due to brodifacoum pellets and brodifacoum wax cakes after 24 hours of poison baiting in no-choice feeding tests was 100 percent. Liquid brodifacoum was comparatively less effective, resulting in 84.33 percent mortality in *M. hurrianae* and 92 percent in *R. rattus.* This single dose anticoagulant has been found to be more effective against other species (Dubock and Kaukeinen 1978, Brooks *et al.* 1980, Mathur and Prakash 1981b). The above observations reveal that, of all the three forms of brodifacoum, pellets are the most effective since it requires shortest feeding period for 100 percent mortality followed by brodifacoum wax cake; the liquid brodifacoum shows the least toxicity. Similar findings have been reported by Saxena and Sharma (1981) against Indian desert Gerbil, Mathur and Prakash (1981a) against *T. indica, M. hurrianae* and *R. rattus.*

Initial poisoning symptoms involved sluggishness and drowsiness followed by partial and then complete paralysis of forelimbs and hind limbs. Pulmonary distress along with nasal, anal and internal bleeding was also observed. Similar findings were reported by Srihari and

TABLE 1

TOXICITY OF BRODIFACOUM (LIQUID, CAKES AND PELLETS) AGAINST *Meriones hurrianae* AND *Rattus rattus*

Species	Forms of poison bait	Conc. (%)	Time of feeding exposure (hrs)	Poison bait intake g/100 gm/ ml/100 gm	Active ingredient intake (mg/kg)	Mortality (%)	Days to death (mean)
Meriones hurrianae	Liquid Brodifacoum	.005	24	5.38	2.64	84.33	7.6
	Brodifacoum cakes	.005	24	5.80	4.27	100	8.6
	Brodifacoum pellets	.005	24	3.84	3.84	100	3.8
Rattus rattus	Liquid Brodifacoum	.005	24	2.19	2.16	92	7.1
	Brodifacoum cakes	.005	24	6.85	4.45	100	7.5
	Brodifacoum pellets	.005	24	6.19	1.87	100	5.3

Sridhara (1977) against *B. bengalensis*, Arora and Doharey (1979) against *F. pennanti* with vacor poisoning. Srivastava *et al.* (1980) reported sluggishness and drowsiness and frequent defaecation with silmurin bait. Chatterjee (1980) reported that drowsiness is due to splanchnic vasodilation, fall in blood pressure and cerebral ischemia.

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2. INTERACTION BETWEEN SAMBAR (*CERVUS UNICOLOR*) AND INDIAN WILD DOG (*CUON ALPINUS*) IN SARISKA NATIONAL PARK

In April 1986, I had seen a wild dog in Sariska and had reported my observations in the journal (*JBNHS* 83, p. 654). On my subsequent visit to the park last month, Shri Pratap Singh, Forest Guard informed me that the three reported wild dogs had separated; two were being sighted near Pandu Pol while one was seen often between the main gate and Kalighati on the main road of the Park.

On 10th January at 10.00 a.m., I was driving back to the main gate when I saw a herd of six female sambar and three young ones, each of which appeared to be about a year old, on a water hole by the roadside some five kilometres from Kalighati. While two females drank water, the rest looked alertly at a female wild dog about twenty yards away. The latter was running and jumping from point to point in an arc of the same radius wagging its tail as if she was trying to play with the former. The sambar on their part did not stamp their feet, did not give an alarm call and did not seem unduly disturbed.

This interaction continued for about a minute. Our jeep was soon followed by two cars which disturbed the herd of sambar and they bolted into the jungle. The wild dog sat down by the roadside looking at the cars. It continued sitting for a while after which it crossed the road in front of our vehicles to go over to the other side. It settled down again into the grass, this time with a couple of cheetal looking towards it. We waited for a while but nothing happened and we drove on. I expressed my surprise at this unusual behaviour to Shri Pratap Singh who informed me that he had observed similar behaviour a few days earlier at the same spot.

This was in sharp contrast to the "normal" behaviour of cheetal and sambar which gave alarm calls and bolted promptly at the arrival of a single wild dog at Kalighati water hole in April, 1986. It may be noted that at that time the three wild dogs were being seen together. The only explanation seems to be that the sambar did not see an individual wild dog as danger any more, while the latter would attempt to attack straying fawns rather than try to pick out an animal from a herd as wild dogs would do while hunting in a pack, thus resulting in this unusual behaviour.

As stated earlier, only three wild dogs have been reported in Sariska and these too have separated. How efficiently they hunt is not known. On enquiry I was told that wild dogs' kills were reported infrequently and usually they were of cheetal fawn. It is significant that though two years have elapsed, the population of wild dogs has not increased according to the reports available.

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3. SOME OBSERVATIONS ON ANTLER CYCLE OF CAPTIVE CHITAL (*CERVUS AXIS*)

Introduction

The Chital or Spotted deer (*Cervus axis*) is the most common among eight species of Indian deer. It is well known that the Chital casts off antlers periodically. But limited information is available on the different aspects of antler cycle in this species. This communication is an attempt to present additional information on different aspects of antler cycle of Chital observed in captivity.

Methods

The data on different aspects of antler cycle of Chital based on the day-to-day observations recorded at the Nandankanan Biological Park, Orissa for a continuous period of 12 years and 6 months (1 October, 1970 to 31 March, 1983) were obtained and studied.

The park is within the biogeographical zone of the species under study. Specimens used for this study include those collected from different parts of Orissa and those born and brought up in the park. The number of Chital stags under observation varied from two to 16.

Results and Discussion

Period of antler casting: During the observation period, 89 antler castings (spike as well as branched) were recorded on a captive population of Chital stags which varied from 3-11 individuals (Table 1). Antler casting occurred during a nine-month period from August to April. All the stags regularly cast their antlers annually and never retained them to the next year. Majority of castings (70 of 89 castings, 79%) occurred during a three-month period from November to January. Ten castings (11%) occurred during a three-month

Table 1

Monthly distribution of casting of antlers and rubbing off velvet by captive Chital stags

Month	Stags casting antlers*	Stags rubbing off velvet**
January	26	2
Febrauary	4	3
March	5	8
April	1	23
May	Nil	31
June	Nil	12
July	Nil	3
August	1	1
September	2	Nil
October	6	Nil
November	20	Nil
December	24	Nil
Total	89	83

* 3-11 stags/year ** 2-16 stags/year

period from February to April and nine castings (10%) were observed during a three-month period from August to October.

Chital stags in velvet and in hard horn may be seen throughout the year (Krishnan 1975). The time of casting of antlers in this species varies in different localities; in Madhya Pradesh and South India, it is usually in August and September. The new antlers are in velvet till the end of December but stags carrying horns in various stages of development have been seen at all seasons (Prater 1971). Antlers were dropped without regard to season at the New York Zoological Park, so antlers in various stages of development could be seen at any time (Crandall 1965). According to Schaller (1976) most of the stags of Kanha National Park cast their antlers between August and October, though only four stags lost their antlers between mid-February and mid-June and a few in July. He further stated that in the Calcutta Zoological Garden antlers were cast between September and February which mostly agree with the present findings. Asdell (1964) stated that the antlers are cast at any time in Sri Lanka but in southern Sri Lanka 75% are cast in April and May. At Bandipur National Park, majority of the antlers are cast during the months of September to November (Sharatchandra and Gadgil 1975). The climate, the biogeography and captive management conditions of this park might be responsible for the difference in the season of antler casting in this species from other areas.

Period of velvet rubbing: As usual with the stags of many species of deer, the Chital stags also rub off the velvet from the antlers each year after completion of their growth. During the study period, 83 observations were made on a captive population of 2-16 Chital stags (Table 1). Rubbing off the velvet occurred during an eight-month period from January to August. The majority of stags (74 of 83 clearings, 89%) cleared their velvet during March-June whereas five clearings (6%) were observed during January-February and four clearings (5%) occurred during July-August.

The velvet of antlers are lost at any time in Sri Lanka (Asdell 1964). April to August are the months of loss of velvet at Bandipur National Park (Sharatchandra and Gadgil 1975).

Duration of antler casting: In the 89 cases studied, casting of antlers of both sides was completed in one day in 57 instances (64%), within two consecutive days in 22 instances (25%), within three days in nine instances (10%) and within five days in only one instance (1%). These data indicate that majority of hard antlers (89%) are cast within 1-2 days.

Both the antlers are usually cast on the same day or on consecutive days but only occasionally the second antler is not cast until two or three days after the first one (Schaller 1967). Antlers of both sides are cast in one or two consecutive days (Acharjyo 1971).

Span of antler growth: The period required from the time of casting of hard antlers to the time when the stags start rubbing off the velvet is taken as the span of antler growth. This span, observed in nine cases, varied approximately from $3\frac{1}{2}$ to $5\frac{1}{2}$ months ($3\frac{1}{2}$ months on four occasions, four months on two occasions, $4\frac{1}{2}$ months on one occasion, five months on one occasion and $5\frac{1}{2}$ months on one occasion).

The time required for antlers to grow from the day of casting the old set until most of the velvet has been rubbed off the new one, observed in 11 stags in the Calcutta Zoological Garden varied from $2^2/_3$ to $6^1/_3$ months mostly depending on the length of antlers (Schaller 1967).

Interval between antler castings: The inter-casting period observed in eight instances among four stags varied from 322-382 days.

The antlers are dropped at intervals of approximately ten to twelve months (Schaller 1967).

Age at first antler casting: Three male Chital born in the park on 17 December, 1971, 24 January, 1975 and 11 December, 1980 cast their spike antlers for the first time on 29-30 November, 1973, 24 December, 1976 and 4-6 January, 1983 respectively. These observations suggested that spike antlers were cast at an age of approximately one year, 11 months (two specimens) and 2 years, one month (one specimen). The knob-like pedicels became visible at an age of approximately 10½ months (one specimen) and 11 months (two specimens). As expected, the coronet or burr was absent in spike antlers.

At the age of 11 to 12 months, the first set of antlers is visible as two prominent skin-covered bumps or knobs, and at about two years the spike antlers are cast (Schaller and De 1964).

Size and weight of cast antlers: Eleven cast spike antlers of yearlings varied from 4.0 to 12.5 cm in length (mean $\bar{x}$ 8.18 cm) and 6.850 to 31.600 gm in weight (mean $\bar{x}$ 2.468 gm). Sixteen of the largest 3-pointed cast antlers measured 68.0 to 82.0 cm in length (mean $\bar{x}$ 77.3 cm) and twelve of the largest 3-pointed cast antlers weighed 574 to 840 gm (mean $\bar{x}$ 716.5 gm).

The antlers of yearlings consist of an unbranched spike usually less than seven inches (17.5 cm) long (Schaller and De 1964). The spike horns of Chital measure less than 25 cm in length (Sharatchandra and Gadgil 1975). An 85 cm antler would be good anywhere and 80 cm in south India, although the greatest record is 101 cm (Prater 1971). The longest antler recorded at Calcutta Zoological Garden by Schaller (1967) was 34 inches (85 cm). According to Krishnan (1975) size and formation of antlers differ with locality and are probably dependent mainly on heredity and strain.

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4. FEEDING PATTERN OF AN EGRET

Driving through a drizzle on 2nd June morning to Kihim, Alibag (Maharashtra), along National Highway 17, I saw a freshwater stream with abruptly straight, precipitous sides. On the banks of the stream was gathered a flock of Egrets of various species. As I kept wondering what could be the purpose of this assemblage, I saw an egret hurriedly step forward to the edge of the stream, and throw itself down on the water. Floating on the surface for a split second it picked up a beakful, and laboriously got air-borne, and flew back to the bank. There it went through the act of swallowing its catch, and fluffed off the water soaked in its feathers. From its completely black beak, and yellow mottled feet, I made out the bird to be a Little Egret *Egretta garzetta.*

One invariably sees egrets working down sloping stream banks, and hunting in shallow waters. Often they feed in irrigated paddy fields in the dry season. However, I am not aware of Egrets hurtling themselves onto water from a height either from my personal birding experience, or from any reports published in bird literature. The action of the egret was reminiscent of "bellyflopping" by the Pond Heron described by G.B.F. Muir, in the Society's *Journal 24*: 366-7, and referred to in the HANDBOOK by Drs Salim Ali & S. Dillon Ripley, Vol. *1*: 63. Major I. R. Grimwood & M.J.C. Brocklehurst in Society's *Journal 81*(3): 696-7 record the Pond Heron stooping onto water from the air in a clumsy, tern-like manner.

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5. THE VEDANTHANGAL WATER-BIRD SANCTUARY: A NEW BREEDING GROUND FOR PELICANS AND PAINTED STORKS

There are no published reports so far regarding breeding of Grey Pelicans (*Pelecanus philippensis*) and Painted Storks (*Mycteria leucocephala*) at Vedanthangal Water-Bird Sanctuary (Chengleput District, Madras). Krishnan (1960) and Spillett (1966) regarded them as visiting birds and not as breeding birds. Nagulu and Ramana Rao (1983) considered that the Pelican was an occasional visitor but not a breeding bird to the Vedanthangal Water-Bird Sanctuary, after their visit in 1981. But pelicans were found breeding at the sanctuary during 1983-84 season (Paulraj 1984). They built nests in tall Barringtonia trees inside the sanctuary tank. But, during the same season no Painted Storks were observed there. During the 1984-85 season, as there was not sufficient water in the Vedanthangal sanctuary tank, the Grey Pelicans only visited and went away without breeding. During the 1985-86 season, they started arriving here from 10.12.85 onwards. Nest building activities were noted from 28.1.86 onwards. At that time there were about 50 Pelicans staying inside the sanctuary tank. Hatchlings were first observed on 24.3.86. A total of twelve nests were found in four large Barringtonia trees. Total count made on 18.4.86 revealed that a maximum population of 102 adult Pelicans stayed during this season as against 65 Pelicans observed during the 1983-84 season (Paulraj 1984).

During the 1985-86 season, the Painted Storks started arriving at Vedanthangal sanctuary from 6.1.86 onwards. Maximum population (127 adults) was reached on 3.3.86. They started building nests from 22.2.86 onwards, when their population was about 55. Hatchlings were first observed on 8.4.86. A total of 22 nests of Painted Storks was noticed both on the Barringtonia and Babul trees.

The Grey Pelicans selected only big Barringtonia trees for nest building and roosting, although sufficiently large *Acacia nilotica* (Babul) trees were also available there. Previous literature and observations reveal that the pelicans were regular visiting birds of the Vedanthangal bird sanctuary, but they started breeding here only recently, from 1984 onwards, whereas the Painted Storks may not be a regular visiting bird, as they were not seen during the 1984 season. Their breeding during the 1985-86 season at Vedanthangal is the first record for this place. Further, it may be expected that the Grey Pelican may breed here regularly during every season if the Vedanthangal sanctuary tank gets filled up and holds water for a duration of at least four months.

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6. EASTERN GREYLAG GEESE *ANSER ANSER RUBRIROSTRIS* SWINHOE IN GUJARAT

I visited Nav Talao, a large but shallow lake nowhere deeper than 3 to 4 ft, on 4 February, 1986. It is situated at Zainabad, Surendranagar district in Gujarat State. On the edges of the lake, there is a thick covering of *Prosopis juliflora,* and there are small islands here and there in the lake where grass grows. I was happy to see more than 200 Rosy Pelicans about the islands, an indication that there was a scarcity of water in the surrounding country.

As I moved my binoculars from the pelicans to the shallow portions of the lake, I saw some huge duck-like birds, which I could not recognize. When I went nearer, I could see the dark heads and light coloured beaks of these birds, and thought that they were geese. A reference to the HANDBOOK OF THE BIRDS OF INDIA AND PAKISTAN, by Salim Ali & S. Dillon Ripley, led me to the conjecture that they were Eastern Greylags.

As good luck would have it, Dr John Constable, Director of the World Wildlife Fund, U.S.A. came to camp that day. I told him about my meeting with these geese, and he offered to visit the lake and confirm their identity.

Reaching the lake we set up the view-scope, and my determination of the birds as Eastern Greylag was confirmed by Dr Constable. There were in all 19 of these geese.

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7. BARHEADED AND GREYLAG GEESE IN GUJARAT

Barheaded and Greylag Geese are comparatively rare in Gujarat. Five birdwatcher friends including myself visited Muli Dam (Dist. Surendranagar) on 14-1-84. We saw 22 Barheaded Geese there on the other side of the lake which had dried up considerably. A majority of these birds were resting and others were moving on the grass-covered undulating wetland. We had a good look at them through a telescope.

On 23-11-84 Rajshri K. Saraghai and I accompanied Dr. Salim Ali for birdwatching at Nal Sarovar (Dist. Ahmedabad). Rajshri and Dr. Salim Ali were in one boat while I, with a friend was in another. My attention was attracted by a small group of unfamiliar birds resting on a tiny islet. I focussed my binoculars on them and immediately recognized them as Greylag Geese. There were 18 to 20 of them. I at once drew the attention of Rajshri towards those birds. At our boats went nearer, they flew away, but prior to that we had a good look at them. Dr. Salim Ali also saw them and confirmed the identification.

Thereafter Rajshri Sarabhai and I saw 64 Greylag Geese again at Thol Lake (Dist. Mehsana) on 21-12-84.

Again I came across some 20 to 22 Greylag Geese when I was watching birds on Gobhlaj Lake (Dist. Kheda) on 14-1-86 along with a young birdwatcher from Ahmedabad.

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8. EGG MOVING BY A SPOTBILL DUCK (*ANAS POECILORHYNCHA*)

On 11 May, 1984, I discovered a nest of a Spotbill duck with a clutch of 11 eggs in one of the *Acacia* planted mounds of Keoladeo National Park, Bharatpur. The nest was a bowl-shaped depression on top of the grassy mound, partially concealed by grass fibres at the opening. The depression was lined with soft, dark grey down feathers, presumably that of the parent. The area around the nest site was dry as the waters had almost dried up save for tiny pools here and there.

I kept track of the development of this nest by visiting it at least once in four days. On 1 June, 1984, I was taken aback to discover that eight of the eggs had been shifted to a point at the foot of the mound, about a metre from the original site. The new nest site was also a neat grassy depression, and as earlier, the nest was lined with some soft feathers. On 6 June, I flushed the incubating parent from the new nest as I was approaching the mound. The whole clutch of 10 eggs had been shifted to the new nest site, rendering the old nest empty (earlier one egg had disappeared). The parents, for some unknown reason deserted the nest after 6 June and hatching success was nil.

It is of interest to note that the bird had shifted the entire clutch, the reason for which is not clear. Oring (1964) reports similar strange and unaccountable incidences of egg moving by three incubating ducks. (two Pintails *Anas acuta* and one mallard *A. platyrhynchos*). On all the occasions he had subjected the nests to considerable disturbance by placing nest traps over them, but he has not been able to arrive at a definite conclusion that the disturbance instigated them to shift the eggs, as, earlier, eggs in numerous nests similarly placed with traps were left intact. Thus, it is unlikely that the minor disturbance created by my visits to the spotbill nest were responsible for the egg moving.

One explanation seems logical. The marshes were rapidly drying up and the original nest site on top of the mound was completely dry with just a few coarse tufts of dry brown grass. The new nest-site at the base of the mound, however, had some amount of moisture left in the form of wet green grass. It is possible that the eggs were moved to the lower site because the area afforded moist and better conditions both for the eggs and the parent.

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9. GREATER SPOTTED EAGLE (*AQUILA CLANGA*) BREEDING IN KEOLADEO NATIONAL PARK, BHARATPUR

A greater spotted eagle (*Aquila clanga*) nest was located on 15th April at the Keoladeo National Park. The nest was situated at a height of *c.* 14 metres on a Kadam (*Mitragyna parvifolia*) tree standing on the northern end of a big Kadam grove in the Keoladhar grassland.

Built on a thin branch about two metres from the main bole of the tree, it was quite difficult to examine. It was constructed mainly with Babool (*Acacia nilotica*) and Kadam (*Mitragyna parvifolia*) twigs, and the central depression was lined with green *Acacia leucophloea* leaves.

The eagles were easily identified as they were dark overall and had little white on the rump. In flight the contrast of dark brown underwing coverts and lighter flight feathers was quite conspicuous.

One oval, white finely speckled with reddish brown egg was laid on 22nd April.

Although Ali and Ripley (1983) mention it as "Resident and breeding in West Pakistan (Baluchistan, Sind and Punjab) and N. India (Gangetic plain), Nepal (lowland) east through Bihar, W. Bengal and Assam". I have not come across any recent record of this species of eagle breeding anywhere in its breeding range within the country.

Abdulali and Panday (1978) described the greater spotted eagle (*Aquila clanga*) as "Winter migrant, does not breed here". It is a new breeding record for Keoladeo National Park. Unfortunately the nesting was not a success as the nest was destroyed in a heavy storm on 26th May and was not rebuilt.

I am grateful to Dr. V. S. Vijayan for his constant encouragement.

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10. AN INSTANCE OF ACTIVE PREDATION BY SCAVENGER VULTURE (*NEOPHRON PERCNOPTERUS GINGINIANUS*) ON CHECKERED KEELBACK WATERSNAKE (*XENOCHROPHIS PISCATOR*) IN KEOLADEO NATIONAL PARK, BHATRATPUR, RAJASTHAN

On 4th July while walking down the main park road we saw a checkered keelback, about 70 cm long wriggling across the road. Suddenly a Scavenger vulture pounced on it from one of the trees lining the road, and started pecking at its head. Holding the snake in its talons, it pecked hard thrice at the head and sat on the weakly struggling snake for the next five minutes before carrying the snake in its beak to its nest on a Kadam tree in the marsh about 100 metres from the road. It left the snake in the nest and flew off and the young on the nest immediately starting pecking at it.

Scavenger vultures are known to kill turtles when they are caught outside water. Recently Drs. V. S. Vijayan and Lalitha reported seeing a Scavenger Vulture feeding on the highly decomposed maggot-ridden body of a nestling of a whitebacked vulture on its nest.

Snakes have not been recorded so far as a food item of scavenger vultures (Ali and Ripley 1983).

We are indebted to Dr. V. S. Vijayan, Project Scientist for help and guidance.

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REFERENCE

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11. A PIED HARRIER *CIRCUS MELANOLEUCOS* IN NORTHWEST MADHYA PRADESH

The Pied Harrier *Circus melanoleucos* (Pennant) is a winter visitor chiefly to the eastern parts of the Indian subcontinent, from Bihar and Orissa east through Bangladesh to Burma (Ripley 1982, Ali and Ripley 1983). According to Ali and Ripley (1969) the species is not recorded north of Bombay in Western India, nor west of Nepal terai and Gorakhpur district in Uttar Pradesh, though putatively seen at Lahore (Pakistan). A male Pied Harrier was seen on three separate occasions in the winter of 1982-83 in the Karera Bustard Sanctuary (25° 31′-25° 40′ N; 78° 5′-78° 12′ E), Shivpuri district in northwest Madhya Pradesh.

It is presumed that the male Pied Harrier stayed in the sanctuary throughout the winter. The species was not seen again in the subsequent three years of my stay in the sanctuary.

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12. DISTRIBUTION OF THE SLENDERBILLED GULL (*LARUS GENEI* BREME) IN THE GULF OF KACHCHH, GUJARAT

There exists no record of the Slenderbilled Gull *Larus genei* Brème from Gujarat, except for a single specimen of this bird collected in Bhavnagar by Dharmakumarsinhji (1955), who considered the bird to be rare on the Saurashtra coast. Ali (1945) does not include it in his list of Kachchh birds. However, south of Gujarat, Navarro (1968) had seen and collected the birds from Bombay (Maharashtra). Sinclair (1976) had also seen the bird in Bombay.

We have seen the bird on a number of occasions in Jamnagar city, and on salt pans and tidal creeks at various places (numbered 1 to 12) around the Gulf of Kachchh. The gull occurred in a variety of situations ranging from freshwater lakes, salt pans, tidal creeks, sea coast and coastal waters (Table 1).

The bird was feeding in a flock at the Salt and Allied Industries (S.A.I.L.), Khijidia (Jamnagar district), where an entire group of about 50 birds swam forward together in a saltwater reservoir, with the birds in the rear constantly flying to join the main body in the front or on the sides. The resultant feeding commotion caused a few Indian Reef Herons, *Egretta gularis*, to fly and join the gulls in the hope of catching some of the fish for themselves.

The call of the bird was heard only once, at the Hadakiya creek (Surajbari). There, a group of 200 birds was resting on a tidal mudbank along with some Herring Gulls (*Larus argentatus*), Caspian Terns (*Sterna caspia*) and Gullbilled Terns (*Gelochelidon nilotica*). Some of the gulls flew over to a nearby ditch of water, first to bathe in and then stand and preen on the water's edge. The Slenderbilled Gulls were in full breeding plumage, the pink on the breast contrasting well with the white head. They appeared to be thinner than the Herring Gull and stood more erect. They called by stretching their heads outward and upward. The call "caw-caw-caw-

Table 1

A summary of the sight records of Slenderbilled Gull during 1979-1986

Sr. No.	Location	Habitat type	No. of birds seen	Date	Observer[1]
1	Okha	Sea coast	1	26.iii.86	T.M.
2	Between Salaya and Ajad Island	Coastal waters	1	14.iii.86	T.M.
3	Pirotan Island	Coastal waters	2	25.iv.86	T.M.
4	Jamnagar	Salt pans	1	22.iii.86	T.M.
5	Jamnagar	Lakhota lake (freshwater)	20–25	23.v.79	L.R.
			Few	01.vi.79	L.R.
			Few	31.i.82	L.R.
			Few	30.xii.82	L.R.
6	S.A.I.L. Khijidia	Salt pans	50	27.xii.84	T.M.
7	Balamba	Salt pans	1	27.xii.85	T.M.
8	Surajbari	Creek	130	19.iii.86	T.M.
			200	20.iii.86	T.M.
9	Mundra	Salt pans	3	22.iii.86	T.M.
10	Navinar Light House, Mundra		7	17.iv.86	T.M.
11	Mandvi	Creek	2	27.iv.86	S.V.
12	Narayan Sarovar	Creek	29	16.vi.86	T.M.

[1] T.M. = Taej Mundkur, L.R. = Lalsinh Raol, S.V. = Shantilal Varu.

caw.......” repeated 4 to 9 times at a stretch, was similar to that of the other gulls. Many of the birds in this flock spent a great deal of time vocalizing, though the calls did not seem to be directed to any specific bird. Gooders (1979) recorded a laughing “kau-kau” call and another, softer and more plaintive than the Blackheaded Gull *Larus ridibundus*, for the Slenderbilled Gull.

It now appears that the Slenderbilled Gull is a common visitor to our coast. The bird was probably overlooked earlier because of its similarity with the Blackheaded Gull in winter plumage (Ali and Ripley 1983). It is also possible that the bird has now increased in number and hence become more obvious whereas it was rare and therefore not recorded when this area was surveyed by C. D. Lester, Geoffrey Archer, Salim Ali and others (Ali 1945).

The bird is known to breed in neighbouring Pakistan during May and June (Ali & Ripley 1983). Some of the birds that we saw in March-May, might have been in the process of congregating prior to migration to their nesting area. However, presence of the bird throughout summer (March to June) in the Gulf of Kachchh would indicate that the bird may also be nesting within our limits, or that the non-breeding individuals, though in their breeding plumage, tend to stay over within our limits. Exploration of some of the inland lakes, such as Chhari Dhandh which is apparently suited for the gull's nesting, during the breeding season is desirable for checking a possible nesting of the bird in India. The marshy areas from Lakhpat to Koteshwar and westwards about the Great Rann of Kachchh might similarly prove productive.

ACKNOWLEDGEMENTS

We are very grateful to Prof. R. M. Naik, Department of Bioscience, Saurashtra University, Rajkot, for his guidance and help. We thank Mr. Himmatsinhji for his opinions on an earlier draft. One of us (T.M.) is thankful to the University Grants Commission for an award of Junior Research Fellowship.

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SHANTILAL N. VARU

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13. AN UNUSUAL FEEDING BEHAVIOUR IN COMMON TERN (*STERNA HIRUNDO*)

In the early morning of 26 March 1986, my Field Assistant and I were cycling down one of the bunds of Mettur Chemicals and Industries Corporation Ltd. at Point Calimere for our regular marine sample collection.

Nearing Reservoir -I, I saw a Common Tern (*Sterna hirundo*) catching a fish from a puddle, which was present on the right side of the bund, by diving from a height into the water. I stopped pedalling and started watching the bird with my binoculars (8×30). The bird went up with the fish to a height of *c.* 35 metres and flew towards the west. The bird was carrying the fish of about 5 cm length by holding it by the middle portion of the body in its bill. The fish slipped but was immediately caught by the bird before it fell a foot. After flying 10 or 15 metres, once again the fish slipped from its bill and the bird caught it again. This process was repeated six times within a distance of *c.* 100 metres (flying parallel to the ground) and finally the fish was swallowed. This seems to be an unusual behaviour among Terns.

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14. A NOTE ON POSSIBLE MIGRATION ROUTE OF SHORT-EARED OWL (*ASIO FLAMMEUS*) OVER SEA

On 27 October, 1985 we were birdwatching at Colaba point which is the southernmost tip of Bombay. There is a large patch of mangrove trees, albeit stunted, which gets almost fully covered during high tide. There is also a path which leads to the lighthouse about three-quarters of a mile out from the shore.

Around 8-30 a.m. we noticed a brownish bird of prey out in the sea on the west side amidst a flock of house crows. It was trying to come towards the land but was constantly being harassed by the crows. As it came nearer we identified it as a short-eared owl (*Asio flammeus*). Its crescent-shaped blackish marking on the underwing was very prominent. The bird did succeed in landing on the rocks below for a brief respite before the house crows harried it again. It was constantly being swooped upon by the house crows and rarely got an opportunity to rest its wings while gliding.

It evoked no response from the grey herons and herring gulls but a lone adult brown-headed gull was seen to dive-bomb it for some time. The owl kept in our view for about 20 minutes before it disappeared towards the golf-course nearby. The morning was clear and sunny, temperature of the day being 35°C. maximum, 25°C minimum.

Short-eared owls are winter visitors spreading over almost the entire Indian peninsula and are not uncommon in some parts of Bombay. Almost exactly 50 years ago Charles McCann (*JBNHS* 38; 1935) while coming by ship to Bombay from Kutch noticed three short-eared owls coming from the west. One of the owls rested on the ship and flew off towards land as soon as the latter was sighted.

It is quite possible that this migratory owl flies over Sind and the Arabian sea to winter in the western parts of our sub-continent. For birds coming to the west coast of India perhaps a direct route over the Arabian sea is preferred. We wish to draw the readers' attention to this point and invite information sightings of a similar nature.

3, Rocky Hill, Malabar Hill,
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NITIN JAMDAR

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Cuffe Parade, Bombay-400 005,
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REFERENCE

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15. OCCURRENCE OF BOURDILLON'S GREAT EARED NIGHTJAR (*EUROSTOPODUS MACROTIS BOURDILLONI*) AT NERIYAMANGALAM, KERALA

Eurostopodus macrotis bourdilloni is a large nightjar so far recorded only from the southern evergreen and moist biotope of the Western Ghats.

While we were ringing birds at Thattakadu Bird Sanctuary in Kerala in June 1985 we saw a Nightjar in a clearing for high tension lines at a place called Neriyamangalam. The bird had its left wing broken and was unable to fly. We took it back to our camp where it was identified as Bourdillon's Great Eared Nightjar (*Eurostopodus macrotis bourdilloni*). Later the bird died and the skin was sent to the BNHS collection where our identification was confirmed. Measurement etc. of specimen from p. 2, arranged as in HANDBOOK. One of us (RS) recorded this species from Sholayar during his Frogmouth survey in the Western Ghats. Later in 1983 when we were camping at Parambikulam, we heard this species on a moonlit night calling continuously from the grass covered top of a hill near the Parambikulam rest house. Later at Ponmudi in 1985 the same call was heard near the KTDC hotel complex. According to published records no specimens have been obtained since 1930 and there is no recent authentic record of the occurrence of this species. The specimen collected from Neriyamangalam and also those records from other areas suggest that the species may range up to Palghat Gap in the north in Kerala.

Details of the bird collected are as follows: Wing: 292 mm; Bill from skull: 22 mm, Bill from feathers: 7 mm; Tarsus: 22 mm; Tail: 177 mm.

Date of collection: 5/6/1985. Place of collection: Neriyamangalam. Altitude: 750 m.

Colour of bare parts of live bird: Iris: Light brown; Bill: Fleshy Brown; Both mandibles: Pale horny black; Legs: Pale fleshy (bright); Claws: Horny brown.

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16. FISH FRY PREDATION BY WHITEBREASTED AND PIED KINGFISHERS AT A NURSERY POND

Whitebreasted kingfisher (*Halcyon smyrnensis*) and kingfisher (*Ceryle rudis*) are among the common waterbirds of Punjab frequenting inland waterbodies. These birds have been reported to consume not only fish fry and crustaceans of commercial value but also frogs, toads and tadpoles, and are therefore considered harmful at fish nurseries (Mason and Lefroy 1912, Ali and Ripley 1970, Mukherjee 1975). However, no information on the extent of predation by these kingfishers on fish fry is available. The observations on this aspect were recorded at a nursery pond (12 × 18 m) of a private fish farm at village Purain *c.* 30 km west of Ludhiana (30° 56′ N, 75° 52 E and *c.* 247 m above mean sea level), Punjab, India.

The eggs of common carp *Cyprinus carpio* collected from a stocking pond were periodically added to the nursery pond during March-April, 1985 for culturing the species. However, carnivorous Indian murrel (*Channa punctatus*) entered the nursery pond from an adjoining unmanaged pond, bred there and consumed common carp almost totally. On 30 June, when the fish fry were sampled from the nursery pond, common carp had been reduced to only about 2% of the total catch and the rest of the fish fry were all Indian murrel.

During May, a flock of kingfishers was observed feeding on fish fry from the nursery pond. It was comprised of two adult and two fledgeling whitebreasted kingfishers and two adult pied kingfishers. One adult whitebreasted kingfisher was, however, shot by the owner of the fish farm prior to the recording of observations. To estimate fish fry mortality due to kingfishers, we observed the birds for nine days (22 through 30 June). Every day, observations were made for one hour from 5.45 to 6.45 a.m. (which was the period of their maximum feeding activity) and the total number of feeding attempts made by kingfishers and number of successful attempts were recorded. The number of captured fish fry fed to the fledgelings by whitebreasted kingfisher was also recorded. The birds were observed from a distance of *c.* 7.5 m without using any hide since they seemed not to be shy of our presence. The length of fish fry at the end of observation period ranged between 11 and 46 mm and averaged 18.66±10.04 mm (mean± s.d., N=53).

On an average, whitebreasted kingfisher made 56.43 feeding attempts per hour and 78.73% of these attempts were successful (Table 1). Since each time this kingfisher caught one fry, the number of fry removed from the pond was 44.45 per hour. There was no significant difference in the number of fry fed to the fledgelings and those eaten by the adult whitebreasted kingfisher ($t=0.085$, $P>0.05$). Hence, half of the fry captured by the adult were fed to the young and half eaten by itself. Pied kingfisher made 10.81 feeding attempts per hour, 66.51% of which were successful (Table 1). In one hour, this kingfisher captured and devoured 7.19 fish fry.

The number of feeding attempts per hour and the number of successful attempts (i.e., the number of fish fry captured) were significantly higher in case of whitebreasted than pied kingfisher ($t=5.784$, $P<0.001$ for number of feeding attempts, and $t=5.8263$, $P<0.001$ for number of successful attempts). Whitebreasted kingfisher captured more than six times the number of fry captured by pied kingfisher. Since half of the captured fry were fed by the whitebreasted kingfisher to its fledgelings, it may be concluded that an adult of this species consumed nearly three times the num-

Table 1

Rate (no./hr) of kingfisher predation on fish fry

Date	Whitebreasted Kingfisher				Pied Kingfisher	
	Total attempts	Successful attempts	Fry fed to young	Fry eaten by adult	Total attempts*	Successful attempts*
22 June	81	62	23	39	28	20
23 June	80	62	28	34	12.5	7
24 June	Birds did not feed because of strong wind					
25 June	40	33	16	17	12	7
26 June	NB	NB	NB	NB	3.5	2.5
27 June	67	55	29	26	2	2
28 June	51	44	24	20	13	8.5
29 June	50	40	25	15	11.5	8
30 June	26	15	9	6	4	2.5
Mean	56.43	44.43	22.00	22.43	10.81	7.19
SD	20.57	17.06	7.12	11.41	8.30	5.82

*Mean of attempts by two adults.
NB = No bird was recorded.

ber of fry consumed by an adult pied kingfisher. Therefore, whitebreasted kingfisher seems to be relatively more injurious to fish fry.

The kingfishers used to start feeding at dawn as soon as they were able to see the prey. They continued feeding with full activity for about an hour, hence we preferred to record observations during this period. The feeding activity progressively reduced in intensity as the day advanced and birds did not feed at all during the hot hours of midday. The peak feeding activity during early morning seems to be due to two reasons: (i) the birds having spent the whole of the night without feeding have to satisfy their hunger early in the morning, and (ii) maximum depletion of dissolved oxygen occurs during this period which forces the fish fry to come to the surface of water and fall an easy prey to kingfishers. During the period of observation, the fledgelings of whitebreasted kingfisher never tried to hunt. They only perched on a *Eucalyptus tereticornis* tree on the bank of the pond. The fledgelings had just left their nest-hole made in the earthen bank of an adjoining rearing pond when we started recording observations. Kingfishers did not attempt hunting whenever the wind blew at a high speed, as for example on 24 June (Table 1). This might be because fish do not come to the water surface since water currents and speedy wind increase the dissolved oxygen content of water. Moreover, kingfishers may not be able to aim accurately at the prey during strong wind.

We can make a very rough estimate of the extent of fish fry mortality due to kingfisher predation. Even if we assume that the kingfishers fed only for one hour (i.e. the period of observation) each day, they would consume about 59 ($44.43 + 7.19 \times 2 = 58.81$) fish fry a day. At this rate, the number of fry consumed by them in 61 days of May and June would be 3599. In view of our assumption, however, the actual fry mortality would be much higher than this estimate since the birds also fed during other parts of the day, although not as vigorously as in the early morning.

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17. PREDATION OF GOLDENBACKED WOODPECKER, *DINOPIUM BENGHALENSE* (LINN.) ON CARDAMOM SHOOT-AND-FRUIT BORER, *DICHOCROCIS PUNCTIFERALIS* (GUENE)

On 16 September, 1984 a Goldenbacked Woodpecker was sighted predating on the cardamom shoot-and-fruit borer, *D. punctiferalis* in Mudigere, Chickamagalur. The woodpecker with its powerful bill chiselled out shoot peelings, located the borer larvae inside the shoot tunnel, and gulped them down. The bird flew to the next cardamom clump. The woodpecker located the borer-infested cardamom sucker and using the black, stiff tail feathers as a brace, held it tight by claws. The bird tapped on the shoot and again began chiselling away shoot peelings.

Of the 60 cardamom plantations surveyed from 1984 to 1986 in Chickamagalur District, Karnataka, the activity of the woodpecker was recorded only in six (10%). On an average, the woodpecker devoured 22.80 per cent of borer larvae (Table 1). The survey indicated that the woodpecker's predatory activity was not found in plantations where —

(a) Pesticides were regularly used and/or

(b) Old trees of species of *Artocarpus, Terminalia, Albizzia, Acacia, Bombax, Sapindus, Cinnamomum, Machilus, Garyga, Alstonia, Dipterocarpus, Elaecarpus* and *Cettis* were absent. The woodpecker's predatory activity was also not recorded in plantations where trees of mostly one species (e.g. *Erythrina lithosperma*) were raised to

Table 1

Woodpecker predation on cardamom borer in some areas of Chickamagalur

Date	Area	Cardamom clumps showing woodpecker predation on borer (%)
16-ix-1984	Arahally	12.5
2-viii-1985	Makhonhally	6.0
4-viii-1985	Hosagiri	15.0
14-ix-1985	Kotegehar	21.0
8-x-1985	Mudigere	31.0
5-vii-1986	Goudahally	51.0

provide shade for cardamom. This is because such plantations offer no suitable sites for nesting and shelter. Because of their uniformity in canopy structure, age and size they are structurally less diverse compared to plantations where natural shade from several species of trees is regulated. Further, trees like *Erythrina* do not harbour insects like grubs, caterpillars and internal wood borers which are preferred by woodpecker.

The predatory activity of woodpecker was confined mostly to valleys. The woodpecker foraged cardamom planted area during evenings, mostly when there was no human intervention. The woodpecker was very actively feeding on borer larvae from August to December, when borer activity is also at peak.

The Pyralid, *D. punctiferalis* is a pest on cardamom (David and Kumaraswami 1982). Despite six sprays recommended for controlling the borer (UAS, 1985), the damage persists. Three species of insect parasites have been recorded on the borer but borer mortality due to parasitisation is negligible (0.05%). In this context, the predatory activity of the woodpecker on the cardamom borer is crucially important.

Thanks are due to the Director, Dr. H. V. Pattanshetti for interest and encouragement.

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18. MOVEMENT OF THE EASTERN SWALLOW (*HIRUNDO RUSTICA GUTTURALIS*) RINGED AT MOOTPUZHA (KERALA)

Every year, in the month of October, local newspapers in Kerala write about the large congregation of Swallows roosting on telegraph wires across Mootpuzha river, close to Mootpuzha bridge. These attract the attention of people crossing over the bridge. The birds had been identified many years earlier by Dr. V. S. Vijayan, of the Society's Bharatpur Hydrobiology project as the Eastern Swallow (*Hirundo rustica*). In October, 1985 attention was again drawn to this congregation by Mr. K. K. Surendran. At his instance, I was asked to try and ring some of the swallows. I, therefore, visited the area with 200 Z-size rings and in the night, with the help of two assistants caught 199 birds by using a large butterfly net made out of a mist net. All the birds were ringed and released at the end of the bridge in bright moonlight. The birds were seen flying back to their roost. Out of the 199 birds ringed three interesting recoveries have been reported from three different places in Tamilnadu and Kerala.

One recovery is from the town of Theni (in Tamil Nadu) close to Periyar in the Western Ghats. The distance from Moovatpuzha to Theni is *c.* 180 km by road. The ring No. Z-25710 was recovered on 2 November, 1986 with the leg of the bird, which had probably been caught by a predator. This was reported by Mr. Kumaraswami, a Forest College trainee, who visited Point Calimere. The ring was recovered almost in a straight line to the east of Mootpuzha.

The second recovery was from the town of Pattukottai (10° 26′ N; 79° 19′E) on 9 Nov., 1986. The bird was found under a lamp-post on a rainy day by Mr. Nateshan. I could get only the ring No. Z-25848 which was removed from the bird. Pattukottai is on the east coast almost in the same line as Theni and about 400 km from the place of ringing. It is about 600 km from Point Calimere Sanctuary.

The third ring was recovered by me during my visit to Parambikulam sanctuary on 21 Feb., 1986. This was found under a bat roost among wing feathers of swallows, warblers and flycatchers scattered around. The dry tarsus bone of the swallow with the ring was recovered, indicating that the kill was at least a few days old. Numerous bats were hanging on the roof which I could not identify, but Mr. J. C. Daniel suggested that the predator could be the Indian False Vampire (*Megaderma lyra*). According to Prater (The BOOK OF INDIAN ANIMALS, 1971) the food of *Megaderma* includes birds like crag martin. We have identified *Megaderma lyra* from the bat roost at Point Calimere's old rest house and during the season I have seen wings and tarsi of birds like *Acrocephalus dumetorum, Sylvia curruca* and various *Muscicapa* spp. under the roost.

The dispersal of the swallows from the Mootpuzha roost is interesting. Having had two recoveries from three locations, one of which is close to Point Calimere, and also considering the large influx of swallows during the months of November and December according to the census data from Point Calimere, we can assume that some of the birds from the Mootpuzha roost perhaps visit Point Calimere also.

We hope to ring more birds of this species during the next year and to try and follow their movements.

I thank Mr. Kumaraswamy and Mr. Nateshan for their kindness in informing us of the ring recovery and making the rings available for confirmation. Special thanks are due to Mr. K. K. Surendran, for providing information on the congregation of swallows at Mootpuzha.

R. SUGATHAN

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HORNBILL HOUSE,
SHAHEED BHAGAT SINGH ROAD,
BOMBAY - 400 023.
August 14, 1986.

19. THE OCCURRENCE OF THE HOUSE CROW (*CORVUS SPLENDENS*) IN PORT BLAIR, SOUTH ANDAMAN ISLAND

I was in Port Blair, South Andaman, between 18-12-1985 and 1-1-1986, staying at a hotel on Marine Hill. There were between 6-10 House Crows (*Corvus splendens*) resident in and around the premises of the hotel (Bay Island). These House Crows were smaller than the Jungle Crows (*Corvus macrorhynchos*) found on these islands and comparatively very few in number. We only saw them around this hotel and the Megapode's Nest guest house complex, run by the government. The neck region was darker than that of House Crows on the mainland, though the call did not differ from the latter. Along with the resident race of the Jungle Crow they would constantly harrass an immature Whitebellied Sea Eagle (*Haliaeetus leucogaster*) over the hotel. We saw them on all the days that we were there.

The House Crow has not been previously recorded on these islands, though Tytler in *Ibis* (1867) stated that they had been introduced for sanitary purposes but does not appear to have thrived or multiplied (Abdulali 1964).

The call of the Jungle Crow of this island is much different from that of the mainland birds'. It is pleasanter and slightly drawn out. The difference is immediately noticeable.

14-7-370 Begum Bazar
Hyderabad - 500 012,
June 20, 1986.

AASHEESH PITTIE

REFERENCE

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20. OCCURRENCE OF THE ASHY MINIVET (*PERICROCOTUS DIVARICATUS*) IN MADRAS CITY (SOUTH INDIA)

It was on 9.xii.1984 that I first saw the Ashy Minivet (*Pericrocotus divaricatus*) at the Guindy National Park, Madras. This species was subsequently sighted in the same area on 16.xii.1984 and 26.i.1985. Again, after a lapse of about ten months, these birds were seen on 15.xii.1985 at the Theosophical Society Estates, adjacent to the Adayar river. The birds were heard on 19.i.1986 at the same locality. Thereafter, they were noticed on two other instances on 23.ii.1986 and 22.iii.1986 at the Society Estates.

The Ashy Minivet is quite distinct from the small Minivet (*Pericrocotus cinnamomeus*) — the only other minivet so far recorded from the Madras area. As it is a common species, I am thoroughly familiar with it and its calls. The Ashy Minivet was definitely larger than the small minivet. It was about the size of a Bulbul but considerably slimmer and with a proportionately longer tail. There were no bright colours present on any of the birds — the birds being ashy-grey, black and white. The upper parts were uniform grey (some appeared to have a brownish tinge) and underparts were whitish. The males had a blackish head and nape with a pale patch on the forehead. A black line ran from the base of the beak through the eye to the crown. The females lacked the black on the head and nape, which were grey like the back. Although the pale forecrown was also present in the females, it appeared less prominent. The tail was darker with white outer tail feathers. In flight, a white bar across the wings was conspicuous.

The Ashy Minivet was observed in pairs or small parties. Only once was a lone bird seen. The largest number seen at a time was five, on 26.i.1985. The birds were quite vocal and their calls were quite different from those of the small minivet. The birds were heard both in flight as well as from perch. The calls, soft and musical, were somewhat reminiscent of a greenish Leaf Warbler (*Phylloscopus trochiloides*) at a distance or, more aptly, a briefer version of the Palm Swift's (*Cypsiurus parvus*) twittering calls. It sounded something like '*Ki-Di-Di*'.

The Ashy Minivet was observed more frequently perched atop bare branches of trees, ranging from 15-40 feet in height. Its stance was more upright. Its behaviour was not different from the other minivets. On a couple of instances, a bird was seen hovering briefly in an attempt to catch a caterpillar. On capturing the prey, it returned to its perch where it battered the insect before devouring it. It was always on the move, never remaining at a perch or a tree for long. The bird kept to itself although other species such as Blackheaded Cuckoo-Shrike (*Coracina melanoptera*), Common Wood-Shrike (*Tephrodornis pondicerianus*), Golden Oriole (*Oriolus oriolus*) and Grey Drongo (*Dicrurus leucophaeus*) were at times seen on the same tree. Once, a minivet was chased by a Grey Drongo, at which the former took off, circled the tree and returned to the same perch.

This species has been accorded the status of an accidental winter vagrant and has been recorded twice within Indian limits (Ali and Ripley, HANDBOOK compact Ed., 1983). The dates of these sightings are given as 19 November, 1897 (near Port Blair, Andamans) and 31 January, 1965 (at Karnala near Bombay). In view of the above, the occurrence of this species in Madras is of significance. Moreover, the sighting of the Ashy Minivet for a second consecutive year shows that the occurrence of this bird in 1984-1985 was not a mere accident. On the other hand, "it is possible that this minivet may really be a scarce but regular winter migrant" (Salim Ali, *pers. comm.*). In view of its inconspicuous nature and lack of flashy colours, the Ashy Minivet is perhaps being overlooked in its wintering areas and I feel a more careful look-out by members of the Society could yield more information as to the exact status of this bird in our country.

I am grateful to Dr. Salim Ali for his comments and encouragement.

V. SANTHARAM

68, I FLOOR,
SANTHOME HIGH ROAD,
MADRAS - 600 028,
July 3, 1986.

21. BUTTRESSED NESTS OF BAYA WEAVER BIRD *PLOCEUS PHILIPPINUS* (LINN.)

(*With a plate*)

This note deals with a field study of the Baya Weaver Bird *Ploceus philippinus* (Linn.) made in the two districts of Eastern Rajasthan, viz. Alwar and Bharatpur during the breeding season in 1982. While studying qualitative and quantitative aspects of abnormality in nest structure, I came across 8 buttressed nests out of 1952(+) studied nests.

All buttressed nests were just a combination of normal nests with a flap of woven strips of various lengths and widths, which were always present in one or more angular region(s) of the nests (see Plate 1). There are four angular regions as can be seen in a normal completed nest of Baya Weaver Bird (See Plate 1).

1. up stalk angular region,
2. down stalk angular region,
3. entrance hall side angular region, and
4. egg chamber side angular region.

Sometimes suspended nests may be caught up in the thorns while swinging about in strong breeze. Buttressing is just a device to minimize the swings from strong wind. Flap of a buttressed nest avoids bending in the entrance tube and also stalk of nests. This helps a nest to keep its position even in thorny bush in windy areas. Sometimes the extreme tip of the entrance tube becomes dilated and loose due to repeated clinging on. To give extra support to the loosened tip and lower part of entrance tube, a vertical flap is created by the bird in a longitudinal direction.

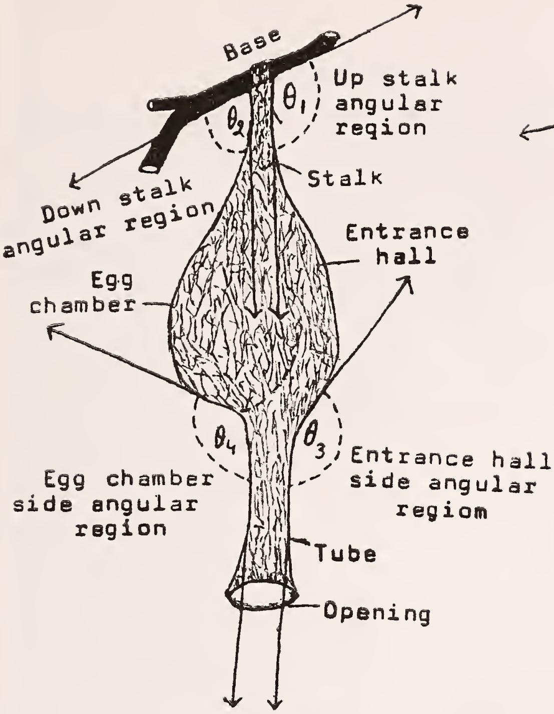
FOREST RANGE OFFICER,
WEST RANGE, GULAB BAGH,
UDAIPUR - 313 001,
RAJASTHAN,
May 14, 1986.

SATISH KUMAR SHARMA

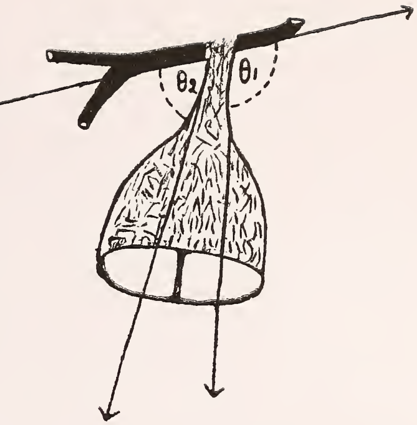
22. OBSERVATIONS ON THE NESTING HABITS OF THE BLACK-THROATED WEAVER BIRD [*PLOCEUS BENGHALENSIS* (LINNEAUS)] IN THE BARODA REGION

INTRODUCTION

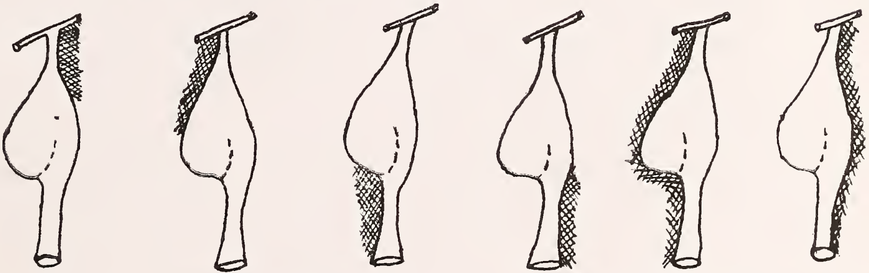
Populations of the Blackthroated Weaver Bird, *Ploceus benghalensis*, are found in three major regions of India: a large broad band from Punjab to Assam; parts of Gujarat (Deesa, Baroda); and the North West Frontier Province (Thar). Due to high population densities in the first area, most major studies (Crook 1960, Ambedkar 1972) have been conducted in the Kumaon terai of Uttar Pradesh where these birds breed in reed swamps and tall grasslands. Their nests are suspended from grasses (*Saccharum munja* and *S. spontaneum*) 1-2 m. above the ground and overland on water. Colonies consist of 3-4 nests where males build more than one nest, are polygynous, and there is a complete lack of paternal care. The aim of this study was to examine variation in nest-site selection, nest structure, inter nest distances, and differences in the repro-


Base
Up stalk angular reqion
θ_1
θ_2
Stalk
Down stalk angular region
Entrance hall
Egg chamber
θ_4
θ_3
Egg chamber side angular region
Entrance hall side angular regiom
Tube
Opening

1:1. Angular regions of a completed nest.


θ_2
θ_1

1:2. Angular regions of a half built nest.



1:3. Up stalk buttress.

1:4. Down stalk buttress.

1:5. Egg chamber side buttress.

1:6. Entrance hall side buttress.

1:7. Down stalk-Egg chamber side complete buttress.

1:8. Up stalk-Entrance hall side complete buttress.

1:3 to 1:8. Few kinds of buttressed nests.

Angular regions and position of butteresses.

ductive biology between the *P. benghalensis* populations of the Kumaon terai and the Baroda region.

OBSERVATIONS

Behavioural observations of two *P. benghalensis* colonies were made during the monsoons of 1983 and 1984. The colony studied in 1983 consisted of one active nest attached to a Papilionaceae shrub along a roadside ditch. Four observations were made on a weekly basis with each session lasting up to five hours. The entrance tube to this nest was very short (6-7 cm.) and the shape of the nest greatly resembles that of the Streaked weaver bird, *P. manyar flaviceps.*

Assured of the occupation of this nest, the male proceeded to build another about 1 m. away on the same plant. At the 'helmet' stage the male plastered the 'chin strap' and the inside borders of the nest with cow dung and stuck bright yellow flowers to it. A marked preference for yellow coloured flowers was exhibited as no other colour was brought to the nest. A second female was not seen nearby and this nest was finally abandoned at this stage. The male continued to make minute rearrangements in the weave and added new supports to the occupied nest while constructing the second nest.

The 1984 study site consisted of a colony of three nests occupied by different pairs and one nest in the 'helmet' stage. Six weekly observations of similar duration were made from mid-August to October. These nests had an inter-nest distance of 1-2 m., and were attached to *Zizyphus oenoplia* plants in a ditch beside a railroad track. Compared to the 1983 colony, they had extremely long (25-30 cm.) entrance tubes. At the start of the breeding season three nests were clearly visible; however, within a month, the entire ditch was covered with a dense layer of *Ipomoea* creepers, thus hiding from view any trace of the colony. Although the main nest support was *Z. oenoplia,* the creeper was also incorporated for additional attachment. Two incomplete nests from nearby baya colonies were found on plants of the same genus (*Zizyphus*) as the *P. benghalensis* colony. A fourth nest, still in the helmet stage, was found but never completed. As each of the others was occupied by a different pair, no male appeared to be polygynous. One male in this colony assisted in parental care by removing faecal pellets from the nest.

DISCUSSION

In contrast to the *P. benghalensis* colonies studied in the Kumaon terai, those found in Baroda exhibited marked differences in various aspects of reproductive biology and nesting habits. Low shrubs were selected as nesting sites rather than reeds and tall grasses. Nests were not in clusters, but separated by at least 1 m. Structural variations in these nests were also present. The entrance tubes varied greatly from 6-30 cm. In addition, all were extremely well attached to supporting plants. Although structural adaptation to new habitat could lead to such variation, as in the case of Baya nests on telegraph lines (Ambedkar 1969), and may even help protect the nest against predators (Regupathy and Davis 1984) or the weather (Davis 1974), it hardly explains the magnitude of the support seen in these *P. benghalensis* nests.

Both the Blackthroated and the Baya weaver birds were seen to nest on *Zizyphus* plants, known as a preferred nesting site of the Baya. Habitat preferences are important in reducing ecological competition and frequency of opportunities for hybridization (Crook 1960), and since the coexistence of two closely related sympatric species depends upon the absence of such competition, the effect of such niche overlap between these populations of *P. benghalensis* and *P. philippinus* needs to be investigated. Also, are the *P. benghalensis* populations in the Baroda and Kumaon terai regions allopatric, and could this account for the great differences in the breeding biology of this bird in two different habitats?

Males were never seen to be successful at polygyny. As the colony was covered with creepers, males who built a second nest could advertise its presence to a female. Nest visibility is essential during courtship because the male attaches bright yellow flowers on the nest to attract the female. Erratic and short monsoon spells (lasting only till September) also reduce the time available to the male to mate twice.

The population density of *P. benghalensis* in and around Baroda is very low. In the two years of study, less than a handful were seen. The male-female ratio is also odd for a polygynous species with both sexes present in equal numbers. What effect do such different nesting habits have on the courtship and mating behaviour of these birds? In what manner does the apparent monogamy affect the behaviour of the male?

These observations suggest that environmental factors limit population growth. Low female densities may play a role in determining breeding success, and alter the behaviour patterns of the male, especially the new behaviour patterns described, such as the additional nest maintenance and removal of faecal pellets. A detailed study of the population density, behavioural variations and overall breeding biology is warranted to resolve the questions raised by this study.

ACKNOWLEDGEMENTS

I am indebted to Prof. R. M. Naik (Bioscience Department, Saurashtra University) for his guidance, and to Dr. G. K. Menon (Zoology Department, M. S. University of Baroda) for valuable suggestions.

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February 4, 1988.

SHAHROUKH MISTRY

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23. ON THE OCCURRENCE OF *CARPODACUS GITHAGINEUS* IN KUTCH

The justification for the inclusion of the Trumpeter Bullfinch in the Kutch Bird List was hitherto in doubt. It was first seen in recent years on March 1, this year, by Mr. Navin Bapat, a member of the Pelican Nature Club of Kutch. According to him 30+ of these birds were present in the rocky ground near and overlooking the Khari River, west of Bhuj. On 7.iii.86 I saw 15+ birds which came to drink water from a hole lower down the southern side of a gully joining the river. Although there were pools of water in the main riverbed from which other birds came to drink water, the Trumpeter Bullfinches preferred to come down only to the hole in the rocks. I should think the reason for this was their preference for settling on rocky surfaces.

The nearest area where this bullfinch has been recorded more often is Sind. Dr. Salim Ali failed to come across it during his surveys in Kutch. However, interestingly enough, though Capt. C. D. Lester did not also see it himself, he has included in in the Kutch list at the end of the last or the beginning of the present century. Thus the present sight record of *Carpodacus githagineus* confirms the older one, and proves that it is a very rare visitor.

JUBILEE GROUND,
BHUJ, KUTCH,
May 30, 1986.

HIMMATSINHJI

24. INDUCING SLEEP IN BIRDS

A unique and interesting behaviour of birds was brought to my notice during a discussion I had with some former trappers of southern Rajasthan. The trappers used to secure their catch of Grey Jungle Fowl (*Gallus sonneratii*) by placing a small flat stone on the ear covert of birds. This used to send the birds to sleep and also stopped them from alerting other birds from the trap. They were later collected and sold in the market. To verify this, I tried out experiments on Domestic Fowl, Redvented Bulbul (*Pycnonotus cafer*) and House Sparrow (*Passer domesticus*) and later demonstrated them to Dr. Salim Ali and Mr. Humayun Abdulali, both leading ornithologists of the Bombay Natural History Society.

A domestic fowl was made to lie on the ground and a small flat stone, weighing about 7 gm, was placed on its ear covert. The bird became inactive and went to sleep immediately and it was observed that the bird closed and turned its toes and moved its tarsus slowly in the air, while in sleep. The bird was allowed to sleep for about 45 minutes during which it was not secured by string.

A small stone usually rolls off and thus becomes ineffective. A heavier stone weighing about 20 gm would hold on more firmly and would be more effective. A fingertip with slight pressure would also bring about the same result.

The same technique was used on Redvented Bulbul and House Sparrow. It put them to sleep almost immediately and proved very effective. A small stone weighing 2.5 gm was used in these cases.

I later used a simple device in the place of a stone or coin. A length of thin steel strip was bent in the middle to form a narrow horseshoe, and an elastic band was put round both sides of the strip in the middle to act as spring and exert pressure. Two small cardboard pieces were fixed to both ends of the bent strip to cover more surface area. This device was used on House Sparrow and it rendered the bird inactive. Thus this simple device can be used effectively instead of stones and coins.

This technique may thus be effective on most birds and it would be of immense help to ornithologists for the study of birds and their banding, without causing the birds any inconvenience. It causes a hypotic effect but I am unable to explain it satisfactorily. Both the above eminent ornithologists were also puzzled and were unable to explain this phenomenon.

41, Panchwati,
Udaipur - 313 001,
Rajasthan,
January 28, 1985.

RAZA H. TEHSIN

25. FRESHWATER TURTLE *LISSEMYS PUNCTATA* (FAMILY TRIONYCHIDAE) WITH MISSING LIMBS IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

Freshwater turtles, of which *Lissemys punctata* is the most abundant, form the major reptilian fauna of Keoladeo National Park.

The Park dried up almost completely during the summers of 1985 and 1987. Terrestrial movements of *Lissemys punctata* were common during this period, although they suffered heavy mortality in the process.

Some of the turtles had their limbs missing; four had no right hind limb, while two had both their hind limbs missing and one with right hind limb and left hind limb toes missing. The terrestrial movements of these turtles were quite peculiar and slow. The turtle with one missing hind limb moved by lifting the whole posterior part of the body with the left hind leg. But the turtle with both the missing limbs had to drag the posterior part of the body over the substratum. Their movement was very restricted and hence they were trapped even in small ditches and were struggling to come out. These turtles were highly sensitive and, at the slightest disturbance, they withdrew their head and limbs. During their movement on land, the flaps of the hind limbs, where the limbs were missing were opened and closed simultaneously with the movement of the other flaps and, when disturbed these flaps were also held tightly. The movement of these turtles in water was almost normal and they could move easily with their forelimbs. One of the possible reasons for the missing limbs is the attempted predation by Scavenger vulture (*Neophron percnopterus*) and King vulture (*Torgos calvus*). During April, 1987 about 27 Scavenger vultures were observed at one place, killing and feeding on the turtles inside the Park.

Lissemys punctata are remarkably well adapted among soft-shelled turtles in being able to protect themselves from predation. Though these turtles can close their shell, the weakest part is apparently the hind limb flaps (Auffenberg 1981) and the bill of the scavenger vulture is very narrow, long and is easily inserted into the narrow, slit-like aperture of the flaps over the hind limbs, tearing off their flesh. No longer able to move, even if offered an opportunity to do so, the turtle slowly dies, (Auffenberg 1981). In the present observations, as the hind limbs were missing, the possible reasons for this might be the attempts of predators, and during this process, the predator must have left the turtle owing to some disturbance and if so, probably the first part attacked by the predator was the right hind limb.

ACKNOWLEDGEMENT

I am grateful to Dr. V. S. Vijayan, Project Scientist, BNHS Hydrobiology Project for his constant encouragement and valuable suggestions.

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May 22, 1987.

REFERENCE

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26. FAT-TAILED GECKO (*EUBLEPHARIS MACULARIUS* BLYTH) CAPTURED FROM A QUARRY

On 1.v.1984 one adult fat-tailed gecko (*Eublepharis macularius* Blyth) was captured by a quarry-man after blasting in the quarry at 1600 hrs. at village Tatarpur (27° 47′ N; 76° 31′ E) in Alwar District. He tied the gecko to a branch of *Leptadenia spartium* and brought it to me at the Forest Nursery at Tatarpur to identify the animal. Actually he wanted to know whether it was poisonous.

I readily recognized it from its attractive coloration. It produced a squeaky mechanical noise by sudden sideways jerks of the head.

After its identification, I released the animal in our forest area. Then I went to the quarry and bagged two more adult individuals from the same old deep quarry.

The area is hilly with sparse vegetation of *Adhatoda vasica, Rhus mysurensis* etc. Earlier, a dense deciduous type of forest was present here but at present there are only denuded hills.

SATISH KUMAR SHARMA

FOREST EXTENSION OFFICER,
VAN CHETNA KENDRA,
GULAB BAGH,
UDAIPUR-313 001,
RAJASTHAN,
September 10, 1987.

27. RUSSELL'S EARTH BOA, *ERYX CONICUS*, PREYING ON A LITTLE BROWN DOVE, *STREPTOPELIA SENEGALENSIS*

In the early hours of 21 October, 1985, while walking along one of the bunds of the Keoladeo National Park, Bharatpur, I saw near one of the numerous Nilgai (*Boselaphus tragocamelus*) dung heaps on the trail, an Earth Boa, *Eryx conicus* peeping out of a hole in the ground. The hole was covered by the dung heap except for a small opening. A few Brahminy Mynas, Pied Mynas, White Cheeked Bulbuls and Jungle Babblers were feeding on and around the dung heap.

Some time later, a little brown dove, *Streptopelia senegalensis,* landed on the dung heap and started pecking around. The snake, which was apparently lying in wait, suddenly emerged and grabbed the dove's foot and coiled around it in a flash. The dove struggled as the snake's coils around it tightened. This went on for about five minutes, when the dove ceased struggling and its nictitating membrane covered its pupil. The snake continued to tighten its coils around the dove for the next ten minutes and then started swallowing it, head first, finally swallowing it completely.

As the boa strangled the dove, the flock of birds which were feeding around the dung heap raised a racket and mobbed the snake.

Whitaker has reported boas preying on birds in a similar fashion, but there is no record of the little brown dove forming a prey of the Russell's Sand boa.

A similar incident was observed again by me a few months back in the National Park.

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March 5, 1988.

VIBHU PRAKASH

28. ADDITIONAL NOTES ON THE PREY ITEMS OF GREEN WHIP SNAKE FROM POINT CALIMERE SANCTUARY, TAMIL NADU

An instance of Green whip snake predating on *Phylloscopus* sp. was recorded (Panneerselvam and Alagar Rajan 1985) from Point Calimere. In another instance on 1 November, 1985 at 1300 hrs near the Old Forest Rest House we heard the distress call of a bird from a *Madhuca longifolia* tree, and to our surprise we noticed a Green whip snake holding a Drongo *Dicrurus adsimilis* by its neck. The snake was choking the bird's neck and the voice of the bird gradually became faint. At about 1315 hrs we saw that the bird was dead. At 1325 half of the bird from head down had been swallowed. After a few minutes the snake moved towards the upper canopy of the tree still holding the half swallowed bird in its mouth.

In one more instance, on 15 February, 1982 at 1400 hrs one of us (P.B.) while on a plant collection trip at Nandupallam area, noticed a Green whip snake (*c.* 1 metre) catching a young monitor lizard (*c.* 30 cm). The snake was seen hanging from a *Manilkara hexandra* tree holding the young wriggling *Varanus* sp. tightly in its mouth. At about 1430 hrs the *Varanus* died and became motionless and the head and neck portion of the *Varanus* had been already swallowed by the snake. Immediately after the *Varanus* died, the snake holding the *Varanus* in its mouth moved into the dense canopy of a nearby tree.

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REFERENCE

PANNEERSELVAM, R., ALAGAR RAJAN, S. (1985): A note on Green whip snake predating on *Phylloscopus* sp. *J. Bombay nat. Hist. Soc. 82*(2): 423.

29. FIRST RECORDS OF *BUFO STOMATICUS* AND *BUFO FERGUSONII* (ANURA: BUFONIDAE) FROM ORISSA, WITH COMMENTS ON THEIR DISTRIBUTION

Studies on the amphibian fauna of Orissa go back to 1965, when Behura wrote a book in Oriya (Orissara Benga: Frogs and toads of Orissa) in which he recorded four species of amphibians from Orissa. Mohanty-Hejmadi (1976) and Mohanty-Hejmadi and Dutta (1976) reported 13 species of amphibians from the State. The present report of two species of *Bufo* from Orissa is a further addition to the amphibian faunal list of the State.

Bufo stomaticus Lutken

Specimens examined: INDIA: Ajmer: Rajputana: BM 1947.2.20.52-53; 80.11.10.132-133 (syntypes of *Bufo andersonii*). Orissa: Sambalpur district: Barpali: KU 200354-85; Brajarajnagar: SKD 2941-51. Tamil Nadu: Tirunelveli district: Mela Neelitha Nallur: CM 60170-71. West Bengal: USNM 38193-94; Calcutta: BM 1909.11.10.2; FMNH 72398-99. Maharashtra: Bombay: BM 83.11.26.105-106. Sikkim: BM 1860.3.19.1362. SRI LANKA: *Colombo*: BM 1932-5.7.2-3; 1955.1.10.85.

Distribution:

India (Assam, West Bengal, Orissa, Bihar, Maharashtra, Karnataka, western and eastern Himalayas up to 6000 ft.). Outside India, the species extends from eastern Iran and southern

Afghanistan to Sind, Pakistan, Nepal, the southern corner of the Arabian Peninsula and Sri Lanka. The report of this species from Sri Lanka is based on only three specimens collected from near Colombo in 1932 by Kirtisinghe (1957). He suggested that the specimens may have been transported to Sri Lanka from India by means of sailing vessels.

Comments on the distribution record from Orissa:

Previously, there was no published record on the occurrence of *Bufo stomaticus* in Orissa. Dr. Dwight Platt, Department of Biology, Bethel College, North Newton, Kansas, U.S.A., collected 31 specimens of the species from Barpali, Sambalpur district, Orissa, during February, 1955-October, 1957. But he did not publish anything on his work in Orissa. During my studies at the University of Kansas, U.S.A., I had an opportunity of examining Dr. Platt's Orissa collections. There were 31 specimens of *B. stomaticus* along with other amphibians collected from the locality. Though Mohanty-Hejmadi (1976) published a report on the amphibian fauna of Orissa, there was not sufficient collection of specimens from Sambalpur district. Her report on the occurrence of *B. andersonii* (*B. stomaticus*) from Sambalpur is most probably based on a juvenile *B. stomaticus.* Recently (November, 1986), I collected 11 specimens of *B. stomaticus* from Brajarajnagar Paper Mill area, Sambalpur district. The animals were collected at night along with *B. melanostictus.*

Bufo fergusonii Boulenger

Specimens examined: INDIA: Kerala: Trivandrum: Travancore: BM 1947.2.21.17 (holotype); 92.10.5.8. Andhra Pradesh: Hyderabad: MSU 6565-66. Orissa: Sambalpur district: Barpali: KU 200340-45. Tamil Nadu: Madras town: BM 1904.4.23.1; Kanyakumari district: CAS 104139. SRI LANKA: No further locality: CAS 85271. Western Province: 10 miles north of Puttalam: AMNH 74274-76. Marichchukkaddi: CM 67834. Trincomalee: FMNH 122054-78; 176341-42.

Distribution:

India (Kerala, Karnataka, Tamil Nadu, Andhra Pradesh and Orissa); Sri Lanka.

Comments on the distribution record from Orissa:

Previous reports (Boulenger 1882, Donahue and Daniel 1967, Daniel 1963) on the distribution record of *Bufo fergusonii* were confined to coastal areas of western, southern and eastern India up to Andhra Pradesh (Hyderabad). The present distribution record of the species in Orissa (Sambalpur district) is based on six specimens (Dr. Platt's collection) identified by me. Like *B. stomaticus,* all these specimens were collected during 1955-1957 and were marked on the jars as unidentified *Bufo* species. Since then, no additional specimens have been collected from Orissa.

Museum abbreviations:

AMNH — American Museum of Natural History, New York, U.S.A.

BM — British Museum (Natural History), London, U.K.

CAS — California Academy of Sciences, San Francisco, U.S.A.

CM — Carnegie Museum of Natural History, Pittsburgh, U.S.A.

FMNH — Field Museum of Natural History, Chicago, U.S.A.

KU	— University of Kansas, Museum of Natural History, U.S.A.
MSU	— Michigan State University Museum, East Lancing, U.S.A.
SKD	— S. K. Dutta's collection.
USNM	— United States National Museum, Washington, D.C., U.S.A.

ACKNOWLEDGEMENTS

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30. BIO-ECOLOGICAL OBSERVATIONS ON *TOR CHILINOIDES* (McCLELLAND)

Tor chilinoides occurs abundantly in the hill streams of Garhwal and is well adapted to the rapid flowing waters. A dark coloured Mahseer, which does not grow to a large size as other species of the genus (*Tor putitora, T. tor, T. mosal* and *T. khudree* etc), it is consumed as food in large quantities in the hills.

A bottom dwelling fish, it is found in deep pools beneath rocks and stones covered with algal slime preferring a stony substratum for its life activities. The depressed and slender body is suitable for the bottom living habit of the fish as also the reduction of the scales on the thorax and abdomen, and horizontally placed paired fins. The fish is very active in its movements and is a schooling fish.

Food and feeding habits:

A column as well as bottom feeder, it is omnivorous. The gut contents included diatoms (*Cymbella, Fragilaria, Navicula, Nitzschia, Synedra*), algae (*Cladophora, Chara, Hydrodictyon, Oedogonium, Pithophora, Gleotrichia, Rivularia*), macrophytes (*Equisetum, Potamogeton* and *Polygonum*), annelids, nematodes, crustaceans and insects (nymphs of Ephemeroptera such as *Baetis, Epeorus, Ephemerella, Heptagenia;* Odonata of the genera *Ictinogomphus, Lestes, Brachydiplax*; Plecoptera of the genera *Perla, Neoperla, Nemoura* and larvae of Trichoptera of genera *Philopotamus* and *Rhyacophila*; Diptera of genera *Blepharocerid, Chironomus, Simulium* and Coleoptera of the genus *Psephenus* etc. Some specimens had skull and other bones of frogs and chitinous body parts of crabs.

Diatoms are found in abundance from October to March and in reduced quantity from April to August. Algae are in abundance during January, March, May and December. The macrophytes are of rare occurrence. It has been observed that insects (their larvae and nymphs) are found in lesser number during December and July and in high numbers during October, November, March, April, May and June. Spawning starvation was observed in this fish; after spawning, the fish feeds voraciously.

Feeds by scraping off algae, diatoms, insects (their larvae and nymphs) from the rocks and stones at the bottom. The lips are thick and hypertrophied and are the main feeding organs. In some populations of fishes which are found in fast flowing streams, there are much enlarged upper and lower horny jaws and it is supposed that these help the fish in scraping and scooping the diatoms, algae, insects (their larvae and nymphs) from the rocks and stones below the waterfalls.

The length of the alimentary canal in the size range of 121 mm to 248 mm total length was found to range between 150 mm and 410 mm and the relative length of the gut ranges between 1.239 and 2.803 times the total length. The size of the gut indicates that the fish is omnivorous.

Sexual dimorphism:

The male and the female can be distinguished easily by the following characters:

1. The snout is pointed and tuberculated in the male while it is not so in the female.
2. In the male, the lips are fleshy and the lower lip is produced backwards into a fleshy labial fold. In the female, on the other hand, the lips are not much thick and the lower lip is not produced into a fleshy labial fold.
3. The anal fin does not reach beyond the base of the caudal fin in the male, while it does so in the female.
4. The mature males are lighter in weight and their ventral profile is straight. The females are heavier with enlarged and distended abdomen.

Breeding period and behaviour:

A monsoon breeder, the fish move upstream in search of shallow spawning pools during the breeding season. Generally, spawning takes place during rainy days. The fish spawns several times during the breeding season. The ripe ovary contains ova in different stages of maturity. Ripe fishes are found abundantly during May and June. The fry make their appearance first in July and are found till September. Appearance of fry during this period further confirms the breeding period of the fish. In the fry, there are two black spots on each scale of the lateral line. A black spot is also present at the base of the caudal fin. The minimum size at first maturity for female is 120 mm and for male 64 mm.

The diameter of mature ova ranges between 1.527-2.956 mm. The fecundity of the fish in the size range 120-207 mm total length was found to range between 952 and 3628.

Hydrological studies indicate that the temperature tolerance of this species ranged from 5°C to 25°C. *T. chilinoides* breeds in the monsoon season when water temperature ranges from 18°C to 25°C. This is the season when the water temperature remains almost constant. The species occurs in waters where concentration of dissolved oxygen ranges from 8.2 ppm to 24.6 ppm and pH 7.0 to 8.3. These hill streams and rivers are clear throughout the year except during the rainy season when they become turbid. Tolerance for low water temperature, neutral and alkaline pH, high concentration of dissolved oxygen and clarity of water are the main factors governing the abundance of *T. chilinoides* in hill streams. The range of free carbon dioxide is 0.1 to 5.4 ppm in these hill streams which is extremely low and such quantity of carbon dioxide does not affect the life of the fish in any manner.

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31. RECORD OF THE MONSTER CRICKET *SCHIZODACTYLUS MONSTROUS* DRURY FROM JAMMU (J. & K.), INDIA

On 2 October, 1978 numerous holes of more or less uniform size and diameter were seen on the wet as well as semi-wet sandy river bank adjacent to the water of the river Basantar near Samba, Jammu. A few such holes were dug out carefully and the insects collected were identified as the monster cricket, *Schizodactylus monstrous* Drury, 1873.

The holes on wet and semi-wet sand on the bank are found within a distance of 3-5 m from the water. The vertical depth was 10-15 cm and the tunnel then ran longitudinally for 25-30 cm to a blind end where the insect was found.

These insects avoid direct light, sun rays and dry wind. In water they swim quite efficiently, near the bank and into deep water.

Lefroy and Howlett (1971) gave its distribution as "Tirhoot, parts of Assam, Bellary, parts of Sind and Multan (Pakistan)". This is the first record of the species from Jammu and Kashmir.

Thanks are due to Dr. Asket Singh, Joint Director of my deptt. and Dr. H. Khajuria, Emeritus Scientist, for constant encouragement and facilities.

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LEFROY, H. M. & HOWLETT, F. M. (1971): Indian Insect Life. To-Day & Tomorrow Printers & Publishers, New Delhi (Reprint).

32. NEW RECORD OF AN APHID PEST ON TEAK

Aphis citricola van der Goot (Hemiptera: Aphididae) is one of the important pests of citrus. In India, it is known to attack *Citrus reticulata* Blanco (loose skinned mandarin orange), *Tridax procumbens* L., a common weed in citrus orchards (Singh and Rao 1978), tree tomato, *Cyphomandra betacea* Sendt. (Agarwala and Ray Choudhury 1981), *Malpighie glabra* L. and *Eupatorium odoratum* L. (Naidu 1980). During the first week of August, 1985, a large number of leaves of four to five-year old teak plants (*Tectona grandis* Linn.) in the forest nursery at the Agricultural College Farm, Dharwad (Karnataka State) were attacked by an aphid which was later identified as *A. citricola.* Severely infested leaves of young plants showed curling and cracking symptoms. This is the first record of *A. citricola* on teak. Since this insect has been reported as a vector of citrus tristeza virus (Naidu 1980), a careful study on the ecology and control of the pest is needed.

We are grateful to Dr. P. A. Brown, British Museum (Natural History), London for identifying the aphid.

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33. *ALEUROMARGINATUS BAUHINIAE* (CORBETT) COMB. NOV. AND *A. THIRUMURTHIENSIS* NOM. NOV. (ALYRODIDAE: HOMOPTERA)

1. **Aleuromarginatus bauhiniae** (Corbett) comb. nov.
   Trialeurodes bauhiniae Corbett, 1935. *J.F. M.S. Museums* 17: 816-817.

Corbett, in 1935, described *Trialeurodes bauhiniae* from Johol (Negri Sembilan), Malaya, the host being *Bauhinia bidentata.* A detailed study of the descriptions and the illustrations of Corbett revealed that the species is assignable to the genus *Aleuromarginatus* and hence the new combination *Aleuromarginatus bauhiniae* (Corbett) is suggested here for *T. bauhiniae* Corbett.

2. **Aleuromarginatus thirumurthiensis** David nom. nov.
   Aleuromarginatus bauhiniae David 1976. *Entomon* 1: 85-86. nec *Trialeurodes bauhiniae* Corbett, 1935.

David (1976) described *Aleuromarginatus bauhiniae* from India, the host being *Bauhinia racemosa.* A critical study indicates that this species differs from that of Corbett in being larger in size, subdorsum with light brown shade on all the thoracic segments and up to the middle of the fifth abdominal segment, absence of a pair of setae laterad of second abdominal segment and in the distribution of setae on the dorsum. It may be pointed out that David (1976) erroneously noted while describing the species, that it has "a pair on basal abdominal segment, four pairs on abdominal segments from second to fifth" which must be amended as "a pair on basal abdominal segment, four pairs on abdominal segments from third to sixth". As this species is thus clearly distinct from that of Corbett, preoccupied by *Aleuromarginatus bauhiniae* (Corbett) comb. nov., it becomes a junior homonym, and thus a new name *Aleuromarginatus thirumurthiensis* David nom. nov. is proposed here.

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34. *TRICHOTROMBIDIUM MUSCARUM* KOLONEV, A NEW ACARINE PARASITE ON HOUSE FLY

(*With a text-figure*)

House fly (*Musca domestica nebulo* Fabricius) is attacked by a number of natural enemies. Among the acarine parasites, Roy and Brown (1970) mentioned certain species of *Gamasus* and *Tyroglyphus* often parasitising fly pupae and sometimes larvae also. Other mites recorded as parasites of housefly include undetermined species of *Microtrombidium* (Acarina: Trombidiidae) (Dhiman and Dhiman 1981) and *Peymotes* (Acari: Peymotidae) (Dhiman and Mittal 1984). Recently during October, 1985, adults of the housefly collected from students' hostel and cafetaria in the premises of the Agricultural College Dharwad (Karnataka State) were found parasitised by a mite larva subsequently identified as *Trichotrombidium muscarum* Kolonev (Acari; Trombidiidae) (Fig. 1). This is a new record of *T. muscarum* as a parasite on housefly. The characteristic feature of the members of Trombidiidae is that they are parasitic only during larval stage (some of which are reddish due to pigments in their tissues) but are free living later on (Roy and Brown 1970). The larva of *T. muscarum* was red, measuring 0.67 mm in length and 0.38 mm in breadth. Although the larvae were found in all parts on the ventral surface of the body, the lateral abdominal and lower surface of the wings attached to the thorax were the preferred regions. The number of mite larvae on a single individual varied from two to six. Flies having more than three mites per individual died within three to six hours of collection.

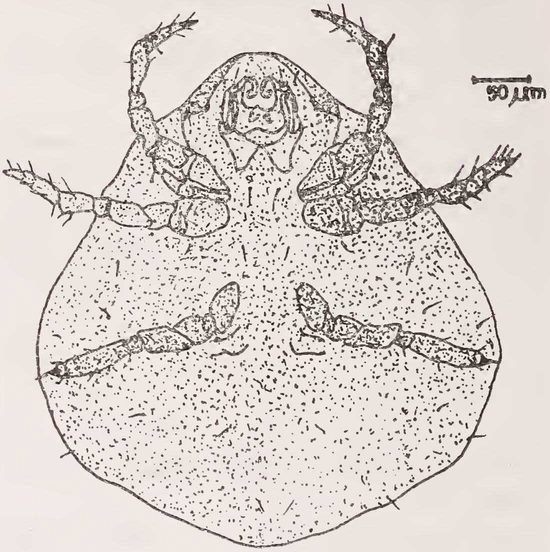

Fig. 1. Larva of *Trichotrombidium muscarum* Kolonev.

An unidentified *Trombidium* found on *Phlebotomus* flies has been suspected to be the carrier of a virus causing Phlebotomus fever in man (McCombie Young *et al.* 1926). It is therefore, necessary to make detailed observations on the development of *T. muscarum*, its association with housefly and effect on man and domestic animals before it is considered as a biological control agent against housefly.

We are grateful to Dr. D. Macfarlane, Commonwealth Institute of Entomology, London (U.K.), for identifying the mite.

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35. OVIPOSITION SITE AND NATURE OF DAMAGE OF NIGER CAPSULE FLY *DIOXYNA SORORCULA* (WIED.) (DIPTERA: TAPHRETIDAE)

(*With a text-figure*)

During the survey of insect pests of niger at Jabalpur (M.P.) the capsule fly *Dioxyna sororcula* (Wied.) was observed for the first time on niger infesting developing seeds in the seed capsule (Jakhmola 1984). In the present investigation a new site for egg laying by the fly was observed. The female fly laid the eggs in the inflorescence inside the ovaries of disc florets by inserting its ovipositor. The egg remains attached to the terminal end of the ovary (Fig. 1). Eggs were laid singly and only one egg was laid in an ovary. The eggs were creamy white in colour and measured 0.69 mm. in length and 0.16 mm. in width. This finding contradicts that of Jakhmola (1984) who reported that the female fly laid the eggs between the disc florets.

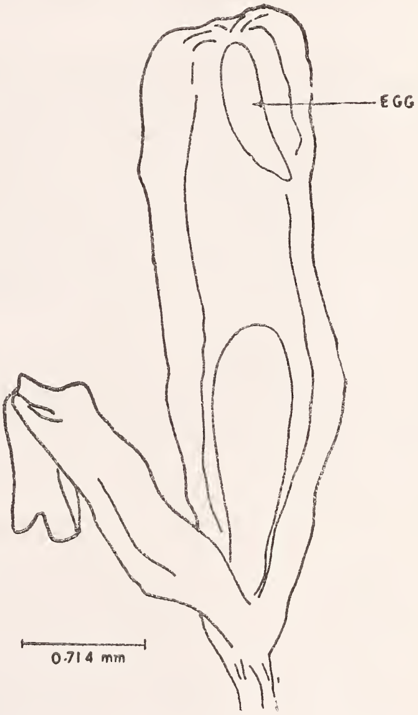

Fig. 1. Exposed ovary of niger showing the egg laid at the terminal portion of the ovary.

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36. COMMENTS ON THE PAPER "HOST PLANTS OF THE FRUIT FLIES (DIPTERA: TEPHRITIDAE) OF THE INDIAN SUBCONTINENT, EXCLUSIVE OF THE SUBFAMILY DACINAE" BY MOHAMMAD ZAKA-UR-RAB

The paper by Zaka-Ur-Rab (1984) contains some inaccuracies which are pointed out here.

The last sentence in the first paragraph under Introduction states: "Another closely related example is that of *Rioxa modestum* (Fabr.) which was recorded by Bezzi (1913) ......". But in the 1913 publication, Bezzi has shifted the species from the genus *Rioxa* and brought it under the genus *Diarrhegma*; since then the valid name is *Diarrhegma modestum* (Fabricius) and not *Rioxa modestum* (Fabr.).

In the second paragraph it is stated: "In the Indian sub-continent the Tephritidae are represented by 60 genera and 138 species...". Instead, it should have been 86 genera and 310 species (Kapoor *et al.* 1980).

In the third paragraph it has been mentioned that out of 102 species comprising this group, host plants of only 21 species are known with any degree of certainty. But for 33 species host plant records have been given with certainty and many more vaguely like in Cucurbitae and Compositae (Asteraceae) plant families in the book by Kapoor *et al.* (1980).

In the main text of the paper, nomenclatural citation of many has been erroneously given or obsolete names have been used. *Chelyophora ceratitina* (Bezzi) should have been treated as *Acroceratitis ceratitina* (Bezzi), *Chelyophora striata* (Froggatt) as *Acroceratitis ceratitina* (Froggatt), *Rhacochlaena cassiae* Munro as *Euphranta* (*Staurella*) *cassiae* (Munro), *Stylia sororcula* (Wied.) as *Dioxyna sororcula* (Wiedemann) and *Tephritis tribulicola* Senior-White as *Orellia tribulicola* (Senior-White).

Under the subfamily Tephritinae, *Centaurea americana* Nutt has been treated as a Tephritid with a mention "This also happens to be the first report of this fruit fly from Kashmir", whereas *Centaurea americana* Nutt has been recorded in the same paper as a cultivated host plant of *Craspedoxantha octopunctata* Bezzi.

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37. ON THE TAXONOMIC STATUS OF *GELASIMUS ACUTUS* STIMPSON (DECAPODA: OCYPODIDAE) PRESENT IN THE NATIONAL COLLECTION OF THE ZOOLOGICAL SURVEY OF INDIA, CALCUTTA

(*With a text-figure*)

While surveying the intertidal macrofauna of the mangrove-fringed estuarine belt of the Sundarbans, India, four species of ocypodid crabs of the genus *Uca* were collected. Among them, the most abundant and widely distributed forms were determined as *Uca* (*Deltuca*) *rosea* (Tweedie). Alcock (1900) recorded *Gelasimus acutus* Stimpson from India and stated clearly that "in the Indian Museum are 92 specimens, chiefly from the Sunderbans and Mergui, but also from Karachi and the Andamans". On examination of the material deposited in the National Collection of the Zoological Survey of India, Calcutta as *G. acutus* Stimpson, it appears that all of them are *U.* (*Deltuca*) *rosea* (Tweedie).

TAXONOMY

Uca (Deltuca) rosea (Tweedie)

1900. *Gelasimus acutus*, Alcock, *J. Asiat. Soc. Bengal, 69*: 360-361.
1932. *Uca manii*, Pearse, *Rec. Indian Mus., 34*(3): 292.
1936. *Uca manii*, Pearse, *Scient. Mon.*, N.Y., *42*: 353.
1937. *Gelasimus manii*, Chopra & Das, *Rec. Indian Mus., 39*: 422.

Material studied: Material present in the National collection of the Zoological Survey of India, Calcutta and the fresh lot recently collected from the Sunderbans, India.

Diagnosis: Carapace with fronto-orbital margin strongly oblique, antero-lateral carapace margin absent, antero-lateral angle acute and produced (Fig. 1A); much enlarged meri of ambulatories, tip of the large chela forceps-like, two grooves, dorsal and subdorsal, covering almost entire length of major dactyl (Fig. 1B); gonopod with broad anterior and posterior flanges, inner process broad and well developed (Fig. 1C).

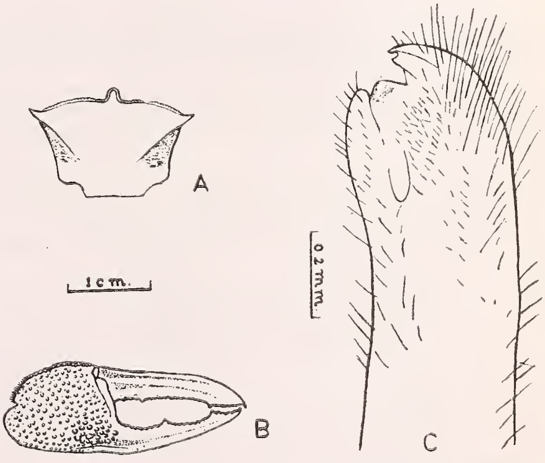

Fig. 1. *Uca* (*Deltuca*) *rosea*: A. Dorsal surface of the carapace of a mature male; B. Dorsal surface of major cheliped; ;C. Gonopod tip (right).

DISCUSSION

In 1900, Alcock recorded *Gelasimus acutus* Stimpson from the Sunderbans, India and in 1932 and 1936, Pearse recorded *Uca manii* Rathbun from the Gangetic delta. Rathbun, Tesch and Tweedie have shown that *Gelasimus acutus* of de Man and that recorded as *acutus* by Alcock from India are not the same form as *G. acutus* Stimpson and synonymised the former species under *G. manii* (Rathbun) (see Chopra and Das 1937). While dealing with the crab *G. manii* (Rathbun) from Mergui and Tavoy coast, Lower Burma, Chopra and Das (1937) stated that "all the specimens are typical, agreeing very closely with the description of de Man and Alcock, as also with examples named by them". In her monograph on the fiddler crabs of the world, Crane (1975) has included not only some material of *U.* (*Deltuca*) *rosea* (Tweedie) from Port Canning, Sunderbans and Nicobar Islands but also synonymised *U. manii* Rathbun recorded by Pearse from the Gangetic delta under *Uca* (*Deltuca*) *rosea* (Tweedie). Further, she also commented that the Indian subcontinent is the habitat for *U.* (*Deltuca*) *rosea* (Tweedie) and not of *U.* (*Deltuca*) *acuta* Stimpson. But she did not comment clearly on the status of *G. acutus* Stimpson recorded by Alcock from India. This led us to re-examine all the material of *G. acutus* Stimpson present in the National collection of the Zoological Survey of India, Calcutta. The re-investigation reveals that these are all *U.* (*Deltuca*) *rosea* (Tweedie), because of the presence of two grooves running almost the entire length of major dactyl, absence of antero-lateral carapace margin and the gonopod structures (Fig. 1C). In addition, fresh material recently collected in large numbers from different areas of the Sunderbans was also studied; these closely resemble *U.* (*Deltuca*) *rosea* (Tweedie). This observation clearly supports the comment of Crane (1975) on the distribution of *rosea* as mentioned earlier. A comparative table is provided to differentiate *rosea* from *acuta* (Table 1).

TABLE 1

COMPARATIVE ACCOUNT OF TWO SPECIES OF *Uca*

Uca acuta (Stimpson)	*Uca* (*Deltuca*) *rosea* (Tweedie)
A single long groove running laterally along almost entire length of major dactyl, the sub-dorsal groove short.	Two grooves running along almost entire length of major dactyl.
Fronto-orbital margin slightly oblique, almost straight.	Fronto-orbital margin strongly oblique.
Antero-lateral carapace margin well-developed.	Antero-lateral carapace margin absent.
Antero-lateral angles acute to varying degrees, moderately produced.	Antero-lateral angles acute and produced.
Meri of Ambulatories enlarged antero-ventral ridge on first leg absent proximally, represented distally by separated fine serrations; corresponding serrations on 2nd, 3rd and 4th legs weak.	Meri of ambulatories much enlarged, antero-ventral ridge on 1st leg absent proximally; distal serrations. non-contiguous, on 1st, 2nd, and 3rd legs, absent on 4th and from postero-ventral ridge on 4th leg.
Gonopod with anterior flange large, posterior rudimentary; inner process minute, scarcely reaching base of flange.	Gonopod with anterior and posterior flanges both broad; inner process broad, well developed.

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Crane, J. (1975): Fiddler Crabs of the World (Ocypodidae: *Uca*). Princeton University Press, New Jersey, 736 pp.

38. ON SOME COLLECTIONS OF MONOGONONT ROTIFERS (ROTIFERA: EUROTATORIA) FROM HARYANA STATE, INDIA

(*With seventeen text-figures*)

Very little is known about the rotifer fauna of Haryana State; the previous report from north-western India (Sharma 1976) included only fifteen species from this region. The present study is, however, based on samples collected from Ambala district (30°21′N, 76°52′ E) between July, 1972-June, 1973 and on various occasions between 1978-84. As a result, twenty species are added to the earlier list.

List of examined taxa.

Class : ROTIFERA
Subclass : EUROTATORIA
Superorder: Monogononta
Order : Ploimida

Family: BRACHIONIDAE
Brachionus angularis (Gosse 1851)
B. bidentata Anderson 1889
B. budapestinensis Daday 1885
B. caudatus Borris & Daday 1894

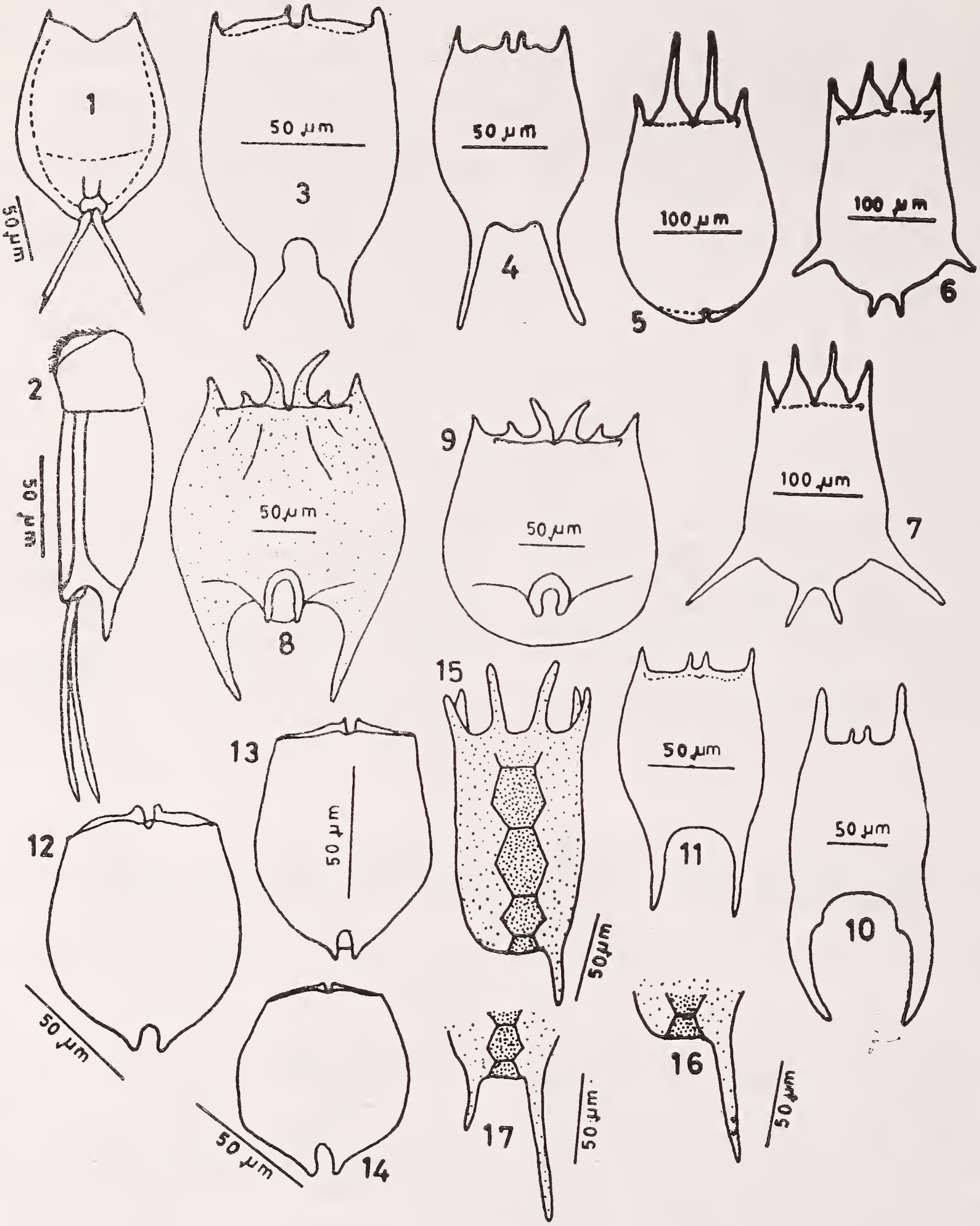
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Fig. 1: *Lecane curvicornis*, ventral view; Fig. 2: *Cephalodella mucronata*, lateral view; Fig. 3: *Brachionus caudatus* f. *aculeatus*, ventral view; Fig. 4: *B. caudatus* f. *personatus*, dorsal view; Fig. 5: *B. calyciflorus* f.*dorcas*, dorsal view; Fig. 6: *B. calyciflorus* f. *anuraeiformis*, dorsal view; Fig. 7: *B. calyciflorus* f. *amphiceros*, dorsal view; Fig. 8: *B. quadridentatus* typical form, ventral view; Fig. 9: *B. quadridentatus* f. *cluniorbicularis*, ventral view; Fig. 10: *B. forficula* typical form, dorsal view; Fig. 11: *B. forficula* f. *minor*, dorsal view; Figs. 12-14: *B. angularis*, ventral views; Figs. 15-17: *Keratella tropica*, cyclomorphic variants.

B. calyciflorus Pallas 1766
B. diversicornis (Daday 1885)
B. falcatus Zacharias 1898
B. forficula Wierzejski 1891
B. quadridentatus (Hermann 1783)
B. patulus (O. F. Müller 1786)
B. rubens Ehrenberg 1838
Keratella tropica (Apstein 1907)
K. procurva (Thorpe 1891)
Platyias quadricornis Ehrenberg 1882

Family: EUCHLANIDAE
Euchlanis dilatata Ehrenberg 1832

Family: MYTILINIDAE
Mytilina acanthophora Hauer 1938
M. ventralis (Ehrenberg 1832)

Family: TRICHOTRIDAE
Trichotria tetractis (Ehrenberg 1832)

Family: COLURELLIDAE
Colurella obtusa (Gosse 1886)
Lepadella ovalis (O. F. Müller 1786)
L. patella (O. F. Müller 1786)

Family: LECANIDAE
Lecane curvicornis Murray 1913
L. luna (O. F. Müller 1776)
L. bulla (Gosse 1885)
L. closterocerca (Schmarda 1898)

Family: NOTOMMATIDAE
Cephalodella forficula (Ehrenberg 1832)
C. mucronata (Harring & Myers 1929)

Family: TRICHOCERCIDAE
Trichocerca similis (Wierzejski 1893)

Family: ASPLANCHNIDAE
Asplanchna brightwelli Gosse 1850

Family: SYNCHAETIDAE
Polyarthra vulgaris Carlin 1943

Family: HEXARTHRICIDAE
Hexarthra cf. *mira* (Hudson 1871)

Family: FILINIDAE
Filinia opoliensis Zacharias 1898
F. longiseta (Ehrenberg 1834)

Family: TESTUDINELLIDAE
Testudinella patina (Hermann 1783)
Pompholyx sulcata Hudson 1885

REMARKS

Thirty-five species of monogonont rotifers, belonging to thirteen families and spread over seventeen eurotatorian genera, are documented presently. Amongst these, *Lecane curvicornis* (Fig. 1) and *Cephalodella mucronata* (Fig. 2) comprise new records from N. W. India. The rotifer fauna of Haryana bears a close affinity with that of the adjoining Punjab State. The common occurrence of *Brachionus* spp. and absence of genus *Notholca* imparts a tropical character to the fauna of this state. Various presently recorded species of *Brachionus* comprise pantropical or cosmopolitan forms of alkaline waters (Sharma 1983).

Considerable morphological plasticity is indicated in the examined taxa of *Brachionus* and *Keratella. B. caudatus* is represented by f. *aculeatus* (Fig. 3) and f. *personatus* (Fig. 4); *B. calyciflorus* includes f. *dorcas* (Fig. 5), f. *anuraeiformis* (Fig. 6) and f. *amphiceros* (Fig. 7). *B. quadridentatus* consists of typical form (Fig. 8) and f. *cluniorbicularis* (Fig. 9) while *B. forficula* includes typical form (Fig. 10) and f. *minor* (Fig. 11). Specimens of *B. angularis* (Figs. 12-14) could be referred to the typical form. In addition, *K. tropica* is represented by various cyclomorphic forms (Figs. 15-17).

Mytilina acanthophora comprises a rare and interesting form in this fauna; it is known so far only from West Bengal (Sharma 1979*a*) and Panjab (Sharma and Sharma 1984). *L. curvicornis* is reported previously from Nagpur, Andhra Pradesh and West Bengal while *C. mucronata* is known only from West Bengal (Sharma 1979*b*). *P. vulgaris*, though common in fish ponds, is reported previously only from eastern India i.e., West Bengal (Sharma 1979*b*) and Orissa (Sharma 1980). Quite likely, other allied species of *P. dolichoptera-vulgaris* group may also be found in this region. The other reported taxa show a wide distribution in this country.

The rotifer community is comprised of maximum of 12-15 species in the studied samples. Of these, *B. angularis, B. calyciflorus, B. rubens* and *K. tropica* invariably dominated the limnetic samples while *B.diversicornis, B. falcatus* and *B. forficula* comprised subdominant elements. *A. brightwelli, P. vulgaris, H. mira* and *Pompholyx sulcata* are also found in plankton samples. On the other hand, *Mytilina* spp., *Trichotria tetractis, Lecane* spp. and *Cephalodella* spp. are associated with littoral region, often infested with attached algae and macrophytes.

More or less clear indications are available relating to trophic status of certain taxa. *B. angularis, B. rubens* and *B. calyciflorus* are found in eutrophic waters while *B. forficula* and *B. diversicornis* are collected presenlty from potable waters. Swarming of *B. rubens,* associated with those of certain cladocerans, i.e. *Daphnia carinata* and *Moina micrura,* is observed in ponds with blooms of blue-green algae. Under such conditions, *B. rubens* occurred as an epizoic on the mentioned cladoceran taxa as has also been observed under identical conditions in West Bengal (Sharma 1983).

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39. NYMPHACEAE OF JAMMU AND KASHMIR

Kashmir is famous for its gardens and lakes. The lakes which are of scenic beauty include Dal lake, Nagin lake, Anchar lake and Wular lake. From spring to autumn these lakes get added beauty by the presence of variously coloured flowering plants, mostly of the family Nymphaceae.

This family of confused taxonomy, includes a number of aquatic herbs, in tropical and north temperate regions of the world. The family is represented by two genera in our area, including genus *Euryale* Salisb., now placed in Euryalaceae in Flora Europaea comprising of only one species, and the second genus *Nymphaea* L. comprising many species.

Several workers including Hooker, f. &

Thomson (1872) in FLORA OF BRITISH INDIA reported only one species, viz. *Nymphaea alba* L. from our area, while Stewart (1972) from his extensive collection has been able to isolate only three species from this area. Kak (1985), while revising Nymphaceae of N. W. Himalaya, has reported six species of *Nymphaea.* On studies based on the herbarium material available in KASH and of fresh collections, we are of the opinion that there are at least eight species present in our area.

Nymphaea L. is a genus with about 40 species distributed all over the world. From the Indian subcontinent, Roxburgh (1832) described six species while J. D. Hooker mentioned only four species. Subramanyam (1962) described only two species, merging *N. lotus* and *N. nouchali* which was followed by Kak (1985), who agrees that the two species are distinct though he has not included *N. nouchali* in his Nymphaceae of N. W. Himalaya. Stewart (1972), in his Catalogue mentions only five species from our area and considered that the study of water nymphs has been neglected. However, the present investigation of the genus *Nymphaea* in our area reveals that eight species can be recognised. An artificial key leading to these species and enumeration for the reference is given below:

KEY TO THE SPECIES

1. Petals usually white (may be pinkish in *N. nouchali*)
    2. Leaves sinuae toothed, pubescent beneath ... . *N. nouchali*
    2a Leaves entire or obscurely toothed
        3. Rhizome creeping
            4. Leaves suborbicular, 10-40 cm across, lobes parallel or diverging; flowers 8-20 cm across; sepals linear-oblong to lanceolate; petals ± ovate; fruit 2-4 cm dia.; seeds ovoid .... *N. alba*
            4a. Leaves orbicular, 9-30 cm, lobes diverging; flowers 20-25 cm across; sepals oblong; petals ovate-oblong; fruit 1-1.7 cm across; seeds obovoid .... *N. lotus*
        3a. Rhizome erect or ascending sometimes with disarticulated branches
            5. Receptacle 4-angled; fruit upto 4 cm across
                6. Leaves circular, 10-40 cm across; flowers 8-15 cm across; stigma 10-15 rayed .... *N. candida*
                6a. Leaves ovate to obovate 5-10 cm across; flowers 3-5 cm across; stigma 4-10 rayed .... *N. tetragona*
            5a. Receptacle not as above; fruit 2-2.5 cm across .... *N. tuberosa*

1a. Petals yellow or variously coloured
    7. Leaves orbicular or elliptic, purple beneath, lobes acute or obtuse; flowers variously coloured .... *N. stellata*
    7a. Leaves roundish oblong, lobes diverging; flowers usually yellow .... *N. mexicana*

ENUMERATIONS

1. *Nymphaea candida* C. Presl. in J. C. Presl, Del. Prag. 224. 1822.
   N. cachmeriana Camb. in Jacq. Voy. 4: 11. 1844. *N. alba* var. *kashmiriana* Hook. f. & Thoms., Fl. Brit. India 1: 114. 1872.
2. *Nymphaea alba* L., Sp. Pl. 510. 1753.
   The commonest water nymph of our area, locally known as *Bumpoosh.* The petioles are dried and used as vegetable and it is said to be of medicinal value.
3. *Nymphaea tetragona* Georgi., Reise Russ. Reich. 1: 220. 1775. *N. pygmaea* Aitch., Hort. Kew ed. 2: 293. 1811. *N. alba* ssp. *tetragona* Korzhinshi Fl. Vort. Eur. 133. 1892.
4. *Nymphaea stellata* Willd., Sp. Pl. 2: 1153. 1799.
5. *Nymphaea mexicana* Zucc. in Abh. Akad Muench. 1: 365. 1832.
6. *Nymphaea lotus* L., Sp. Pl. 511. 1753.
7. *Nymphaea tuberosa* Paine, Cat. Pl. Oneida. 132. 1890.

8. *Nymphaea nouchali* Burm. f., Fl. Ind. 120. 1786. *N. lotus* var. *pubescens* Hook. f. & Thoms., Fl. Brit. India 1: 114. 1872. non L.

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ROXBURGH, W. (1832): Flora Indica, 2nd ed. Calcutta.

STEWART, R. R. (1972): Catalogue of Vascular Plants of West Pakistan and Kashmir. Karachi, Pakistan.

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40. REDISCOVERY OF THREE RARE PLANTS FROM KUMAUN HIMALAYA

During the study of the flora of Kumaun Himalaya, three rare species, namely *Psilotum nudum* (Linn.) Beauv. (Psilotaceae), *Asplenium nidus* Linn. (Aspleniaceae) and *Wallichia densiflora* Mart. (Palmaceae) were collected. Earlier literature and records reveal that these species have been collected after a lapse of a considerable period from the Kumaun Himalaya. These species appear to be extremely rare because they were collected only once from one particular locality and are almost on the verge of extinction. It is likely that they may not be found in the future in the Kumaun Himalaya, if proper steps for their conservation are not taken in time.

The present paper reports the rediscovery of these three plants in Kumaun Himalaya along with other relevant information. The field number along with collector's name is given in brackets. The voucher specimens are deposited in the Herbarium, Botany Department, D. S. B. College, Kumaun University, Naini Tal.

1. **Asplenium nidus** Linn., Sp. Pl. 1079. 1753; Clarke, Trans. Linn. Soc. Lond. 2 (Bot.) 1; 475, 1880; Hope, J. Bombay nat. Hist. Soc. 13: 459. 1901; Duthie, Cat. Pl. Kumaun 224. 1906; Dhir, Biblioth. Pterid. 1: 113. 1980; Dixit, Census Indian Pterid. 119. 1984. *Thamnopteris nidus* Presl, Epim. Bot. 68. 1849; Bedd., Handb. Ferns Brit. India 137. 1883.

This species is reported to occur in India from Assam to Garhwal, the latter being the westernmost limit of its distribution. The occurrence of this species in Kumaun and Hope (1901), on the basis of collections made Garhwal Himalaya has been mentioned by by Strachey and Winterbottom (1848) from Ramganga river at an altitude of 750 m., and by Duthie (1884) from near Askote between 900-1200 m and from Gori valley between 900-1200 m (1886). Since then, this species has neither been collected nor reported from these previously known localities by subsequent workers. It has now been collected from near Didihat in Pithoragarh district after a lapse of more that a hundred years.

Specimens examined: Kumaun Himalaya: Pithoragarh district, near Askote around 1,400 m (Samant, 1311).

Ecology: Extremely rare fern and grows epiphytically on the tree trunks of *Quercus leucotrichophora* A. Camus in deep shaded ravines.

2. **Psilotum nudum** (Linn.) P. Beauv., Prodr. Fam. Aetheog. 112. 1805; Duthie, Cat. Pl. Kumaun 232. 1906. *Lycopodium nudum* Linn., Sp. Pl. 1100. 1753. *Psilotum triquetrum* Sw., Schrad. Journ. Bot. 1800 (2): 109. 1801.

In India, this species is fairly well represented in Arunachal Pradesh, Assam, Madhya Pradesh, South and Western India, West Bengal, Bhutan, Sikkim, Upper Gangetic plains, Kumaun, Garhwal and Himachal Pradesh. In Kumaun, its occurrence was reported by Duthie (1906), based on the collections made by Strachey and Winterbottom during the years 1846-1849 from Gagas river in Almora district at an altitude of 1300 m. Since then, the presence of this species from Kumaun is being recorded after nearly 126 years.

Specimens examined: Kumaun Himalaya: Pithoragarh district, near Askote around 1500 m (Samant, 1975).

Ecology: Extremely rare and grows epiphytically on the tree trunks of *Syzyzium cumini* (Linn.) Skeel.

3. **Wallichia densiflora** Mart., Hist. Nat. Palm. 3: 190. 1838; Hook. f., Fl. Brit. Ind. 6: 419. 1892; Prain, Bengal pl. 1094. 1903; Brandis, Ind. Trees 655. 1906; Duthie, Cat. Pl. Kumaun 192. 1906; Osmaston, For. Fl. Kumaun 543. 1927. *Wallichia oblongifolia* Griff., Cal. Journ. Nat. Hist. 5: 486. 1835. *Harina oblongifolia* Griff., Palms Brit. Ind. 173. t. 237. ABC. 1854.

This species occurs throughout the tropical Himalayas from Kumaun to Assam and Chittagong, and was collected from Kumaun by Strachey and Winterbottom during the years 1846-1849 from Ramganga river and Bhabar region between 300-800 m. Later, Osmaston (1927) reported it as fairly common in the central and outer regions of Kumaun Himalaya in deep, shady ravines between 330-1000 m. The present collection of this species from Kumaun Himalaya shows that it is being collected after a lapse of nearly fifty years.

Specimens examined: Kumaun Himalaya: Naini Tal district, near Bhujia Ghat at 600 m (Pangtey, 437).

Ecology: Extremely rare and grows always in deep shady ravines along perennial streams in miscellaneous forest.

ACKNOWLEDGEMENT

We are grateful to the Head, Botany Department, D. S. B. College, Kumaun University, Naini Tal for providing necessary facilities.

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41. OCCURRENCE OF *SPERMACOCE MAURITIANA* O. GIDEON IN WESTERN INDIA

Spermacoce mauritiana O. Gideon, even though quite a common species in India, has often been misidentified. While determining the identity of various species of *Borreria* collected from Ratnagiri District, we noticed this distinct looking plant which resembled *Borreria ocymoides* DC. in appearance. On further critical examination it was identified as *Borreria repens* DC. given in Backer & Bakh. f. Fl. Java — a species now correctly called *Spermacoce mauritiana* Gideon. Deb. & Dutta (1984) have reported this species under *Spermacoce decandollei* from N. E. India and Tamilnadu. They seem to have overlooked Gideon's name and thus made an additional superfluous name. We give below the correct nomenclature, description, distribution and specimens examined by us at Blatter Herbarium and at B.S.I., Pune.

Spermacoce mauritiana O. Gideon in Verd. Kew Bull. 37: 547, 1983. *Borreria repens* DC. Prodr. 4: 542. 1830 (non *Spermacoce repens* Willd. ex Chem. & Schlecht. 1928): Backer & Bakh. f. Fl. Java 2: 353. 1965. *Begelowia parviflora* Sieber, Fl. Maurit. no. 144: 1825 (nom. nud.) (non Spreng. 1825). *S. decandollei* Deb. & Dutta in Journ. Econ. Tax. Bot. 5, 1044, t. 2. 1984 (nom. *superfluous*).

Erect or decumbent herb, 10-45 cm tall. Stem 4-angled, sparsely hairy. Leaves subsessile, elliptic, up to 3.5 × 1.5 cm, acute or subacute, base narrowed, glabrous or minutely hairy above, more hairy on the nerves beneath. Heads terminal or axillary, up to 0.6 cm across, many flowered; bracts 4-8; bracteoles filiform. Calyx 2-lobed; tube 0.5 mm long. Corolla lobes 4, 1.0 mm long, white; stamens 4, attached at the sinus. Style short; stigma bilobed. Capsule + 1.0 mm long (excluding 2 calyx teeth), thin walled, glabrescent or puberulous in the upper half. Seeds oblong, up to 1.0 mm long, brown.

The species is usually found in moist places, among grasses along roadsides, in harvested rice fields, etc.

Flowers & Fruits: August-November.

Fig.: Deb. & Datta l.c.

Distribution in Western India:

Maharashtra, Goa, Karnataka, Tamilnadu and Kerala.

Specimens examined:

Blatter Herbarium — Mistry M. K.: Ratnagiri 1095, Dapoli — 1330, Machal — 1634; Almeida, S. M.: Ratnagiri 348 & 752; Almeida, M. R.: Dhopeshwar — Maharashtra — 4666.

BSI Herbarium — Singh, N. P.: Cadal Nanacha dongar — Goa 124484; Rao: 92870; Khisti: Sangam — 125228; Rao: Sampaje, Karnataka — 74750; & Mercara — Kotagiri Road — 24637; Subramanian: Tenmalai — Kerala 76904; Vasaveda: Edamon — Kerala 37064.

ACKNOWLEDGEMENTS

We are grateful to the Principal, St. Xavier's College, Bombay and the authorities of BSI herbarium, Pune for rendering facilities for reference work in the herbarium; to Dr. (Mrs.) A. R. Daruwala, our colleague, and Mr. M. R. Almeida of Alchemie Research Centre, Thane, for the help rendered in preparing this note.

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42. *GOODYERA FUMATA* THW. (ORCHIDACEAE) — A NEW RECORD FOR SOUTH INDIA

(*With a text-figure*)

During a revisionary study on Nearctic orchids of India under the National Flora Project of the Botanical Survey of India, a collection (Acc. 86612, MH) made from Kerala in 1942 and identified as *Hetaeria ovalifolia* (Wt.) Benth., upon critical study has been proved to be *Goodyera fumata* Thw. which was hitherto known only from Sikkim and Arunachal Pradesh in India, and hence is reported here as a new addition to the South Indian orchid flora.

Goodyera fumata has a very close resemblance to *Hetaeria ovalifolia* in its robust vegetative features but can be differentiated from the latter by careful observation of the following characters shown in the key.

Leaves with branched midvein. Midlobe of lip longer than the lateral lobes, linear-oblong. Column with single ventral stigma .... *Goodyera fumata*
Leaves with unbranched midvein. Midlobe of lip subequal to lateral lobes, ovate. Column with two lateral stigmata .... *Hetaeria ovalifolia*

Goodyera fumata Thw. has been listed below with a line drawings (Fig. 1) and a brief note on its distribution in order to facilitate field collectors to locate it elsewhere in the country.

Goodyera fumata Thw. Enum. Pl. Zeyl. 314. 1864; Jayaweera in Dass. et Fosberg, Fl. Ceylon 2: 310. fig. 137. 1981; Hook. f. Fl. Brit. India 6: 111. 1890; King and Pantl. in Ann. Roy. Bot. Gard. Calcutta 8: 284. t. 377. 1898; Seidenfaden in Dansk Bot. Arkiv 32(2): 21. fig. 7. 1978; A. N. Rao in Vij (ed.), Biol. Cons. Cult. Orch. 326. 1986.

Specimen examined: Kerala, Tinne Valley Hills, Acc. No. 86612 (MH), Oct. 1942.

Distribution: India (Sikkim, Arunachal Pradesh, Kerala), Sri Lanka, Yunnan, Tonkin, Taiwan, Thailand, Ryukyu, Philippines and Japan.

Note: The present report of its occurrence in Kerala is interestingly a connecting link

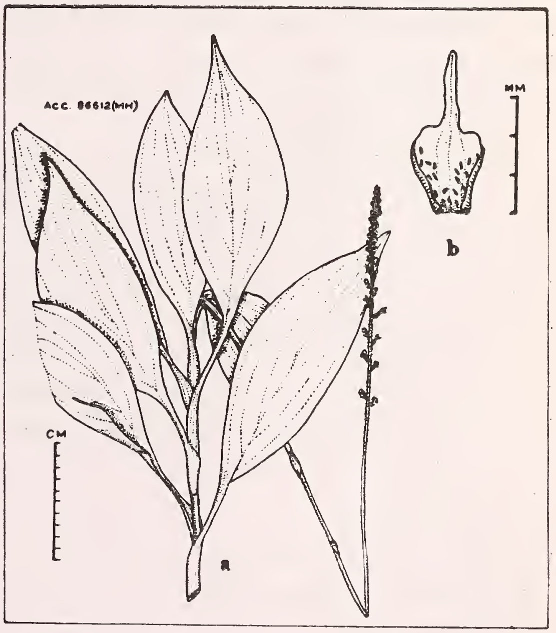

Fig. 1. *Goodyera fumata* Thw.: a. Plant; b. Lip.

between Sri Lanka and Northeast India thereby giving a clue of its possible occurrence in intervening states namely Tamilnadu, Andhra Pradesh, Orissa and West Bengal.

ACKNOWLEDGEMENTS

Sincere thanks are due to Dr. S. N. Hegde, Orchidologist, Tipi, Forest Department of Arunachal Pradesh for facilities and encouragement and to the Director, Botanical Survey of India, Howrah for allotting to me the revisionary work of Nearctic orchids under the National Flora Project.

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43. A NOTE ON THE OCCURRENCE OF *DIDYMOPLEXIS PALLENS* GRIFF. (ORCHIDACEAE) IN ANDHRA PRADESH

During the study on the West Godavari district (16°15′-17°30′ N; 80°50′-81°55′ E) flora of Andhra Pradesh, in one of the collection trips we collected an interesting saprophytic taxon in fruiting condition along the Eastern Ghats (*c.* 600 m).

The taxon has been identified as *Didymoplexis pallens* Griff. (Orchidaceae). This is the only species, among Indian saprophytic orchids, which has got the capsules with 10-20 cm long erect pedicels.

Didymoplexis pallens Griff. is one among the rare and endangered orchids of India. In South India it is known so far only from Coorg (Karanataka State), but it is common in Sikkim, West Bengal, Assam, Meghalaya and Arunachal Pradesh in Northeastern Himalayas. The present collection is the first record from the Eastern Ghats, and bridges the gap between Western Ghats and Northeastern parts of India. It may possibly be located in the adjacent districts, viz. East Godavari and Visakhapatnam districts and also in Orissa State, if collections are made immediately after the first rains, since the plant completes its life cycle within 2-3 weeks.

Fruiting: May-July

Distribution: India (West Bengal, Sikkim, Meghalaya and Arunachal Pradesh in N.E. Himalayas); Burma (Yahudan); Indonesia (Java) and Malaysia.

Specimen studied: Andhra Pradesh: PV *et* TAR. 8259, Papi Hills, Chilakaluru, West Godavari District, 25 June 1980.

ACKNOWLEDGEMENTS

We thank Dr. A. N. Rao of the Orchid Research Centre, Tipi, Arunachal Pradesh for his suggestions.

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44. OCCURRENCE OF *PISTACIA ATLANTICA* DEAF. SSP. *CABULICA* ((STOCKS) RECH. F., IN HIMACHAL PRADESH

While identifying a collection of plants from Himachal Pradesh, received through Mr. N. K. Negi, retired Divisional Forest Officer of Himachal Pradesh Forest Department, I came across a specimen of *Pistacia* Linn. which could not be matched with any of the species of this genus known to occur in India. Critical examination revealed that the plant in question was *P. atlantica* Desf. ssp. *cabulica,* which occurs principally in Afghanistan, and alst in southern Iran and Pakistan. The present paper records for the first time from the wild (N K Negi, *pers. commun.*) the occurrence of this Pistacio tree in Himachal Pradesh.

Pistacia atlantica Desf. Fl. Atlant. 2: 364. 1800. ssp. **cabulica** (Stocks) Rech. f., Fl. Iran. 63:5. 1969; Y.J. Nasir in E. Nasir & S. I. Ali, Fl. West, Pak. 152: 15, fig. 4, B, & C. 1983. *Pistacia cabulica* Stocks in J. D. Hooker, Kew J. Bot. 4: 143. 1852. *Pistacia mutica* Fisch. & Mey ssp. *cabulica* (Stocks) Engler in DC. Monogr. Phan 4: 287. 1883.

A tree up to 7 m tall. *Twigs* puberulous. *Leaves* imparipinnate. *Leaflets* (3-) 5-9 in number, 26-70 x 8-22 mm, lanceolate; petiole winged, puberulous. *Panicle* extra-axillary, 7-13 cm long, puberulous. *Bracts* 1-2 mm long, lanceolate, scarious, deciduous, brown. *Ovary* ovoid, ± 1 mm long. *Styles* 3, reflexed. *Drupe* 5-6.5 mm long, sub-orbicular-oblique in outline, compressed, apiculate; epicarp nervose, yellow-brown.

Specimen examined:

Village Siplo, 2200 m, District Kinnaur (Himachal Pradesh), May-June 1986, *N. K. Negi* s.n. (DD). 'Wild'.

Distribution: Southern Iran, Afghanistan, Pakistan and Himachal Pradesh in India.

New Forest,
Dehra Dun,
February 4, 1988.

H. B. NAITHANI

45. NEW RECORD OF *CALYMPERES THWAITESII* BESCH. SUBSP. *FORDII* FLEISCH. FROM MAHARASHTRA STATE, INDIA[1]

(*With a plate*)

Calymperes thwaitesii Besch. subsp. *fordii* Fleisch., an epiphytic moss which mostly grows on the trunk of *Cocos nucifera* and *Mangifera indica* at Bombay is being reported for the first time from Maharashtra. Presence of cluster of septate gemmae at the leaf apex is the most characteristic feature of this moss.

As this moss grows around the coastal region at Bombay, it is ecologically considered as an indicator of maritime climate.

Indian mosses had attracted the attention of many bryologists like De la Pottier, Bruhl (1931), Dixon (1921), G. Foreau (1961), Norkett (1961), Chopra (1974), Gangulee (1972) who have described these from different localities in India. However, little attention has been paid to the mosses of western India. An epiphytic moss on the trunk of *Cocos nucifera* (coconut) and *Mangifera indica* (mango), after careful study has been confirmed as *Calymperes thwaitesii* Besch. This species was reported by Bruhl (1931) from Kanara. As there is no previous report of this moss from this state it is considered to be a new record from Maharashtra. Recently the author and Akhtar Hasan Rizvi collected it at different localities around Bombay, viz. Borivli, Bassein and Kankeshwar, from the trunks of the above trees growing near the sea shore.

Calymperes thwaitesii Besch., Ann. Sc. Nat. Bot. Ser. 8, 1: 270, 306. 1896. ssp. *fordii* (Besch.) Fleisch., Musci Fl. Buitenzorg 1: 240-258. 1904. (*Calymperes*, 1896). (Plate I).

Plants small, forming short bluish or yellowish green tuft with a felt of rhizoids in their lower part. Stem 1 to 1.5 cm. high, enclosed by leaves and fine smooth axillary rhizoids. Leaves when dry nearly erect, slightly contorted and incurved. On keeping them moist, they become erecto-patent, lanceolate, concave with tortuous wavy margin and round apex. Margin of the leaf apex is denticulate. Terminal leaves are acuminate, lingulate and with an excurrent nerve. Transversely septated, clavate gemmae present only at the tips of terminal leaves. The hyaline basal part of the leaf narrow, oval with loosely arranged rectangular to polygonal cells. Each hyaline cell towards the mid is 60 μ long and 28 μ long and 14.4 μ broad. The top cells of the hyaline basal region of leaf nearly rhomboidal. *Teniolae* (intralaminar cells) are rectangular, elongated cells in 3-5 series: persistent from the basal hyaline region to the middle part of leaf. Teniolae are 44 μ long and 6.4 μ broad. Hyaline marginal cells at the leaf base in 1-2 series. The chlorophyllose laminar cells are prosenchymatous, thin-walled, quadrate to hexagonal, 10 μ long, 8.8 μ broad. Midrib prominent, percurrent in normal leaves, but excurrent in gemmiferous leaves. Cells of the midrib rectangular, elongated and in 5-6 series, cells of midrib 73 μ long and 14 μ broad. Basal part of the midrib becomes flat higher up, circular with one row of 'deuter' or water -conduction cells. There are two steridal bands above and below the deuter cells. A star-like cluster of clavate gemmae present at the tip of the excurrent midrib of the leaves. Gemmae transversely septate, light green in colour, 187 μ long and 30 μ broad.

Distribution: Kanara (Bruhl 1931), Bassein, Uran, Kankeshwar, Bombay (Dabhade 1980, Akhtar Hasan 1987). This species is cosmopolitan all over the coastal regions in tropics.

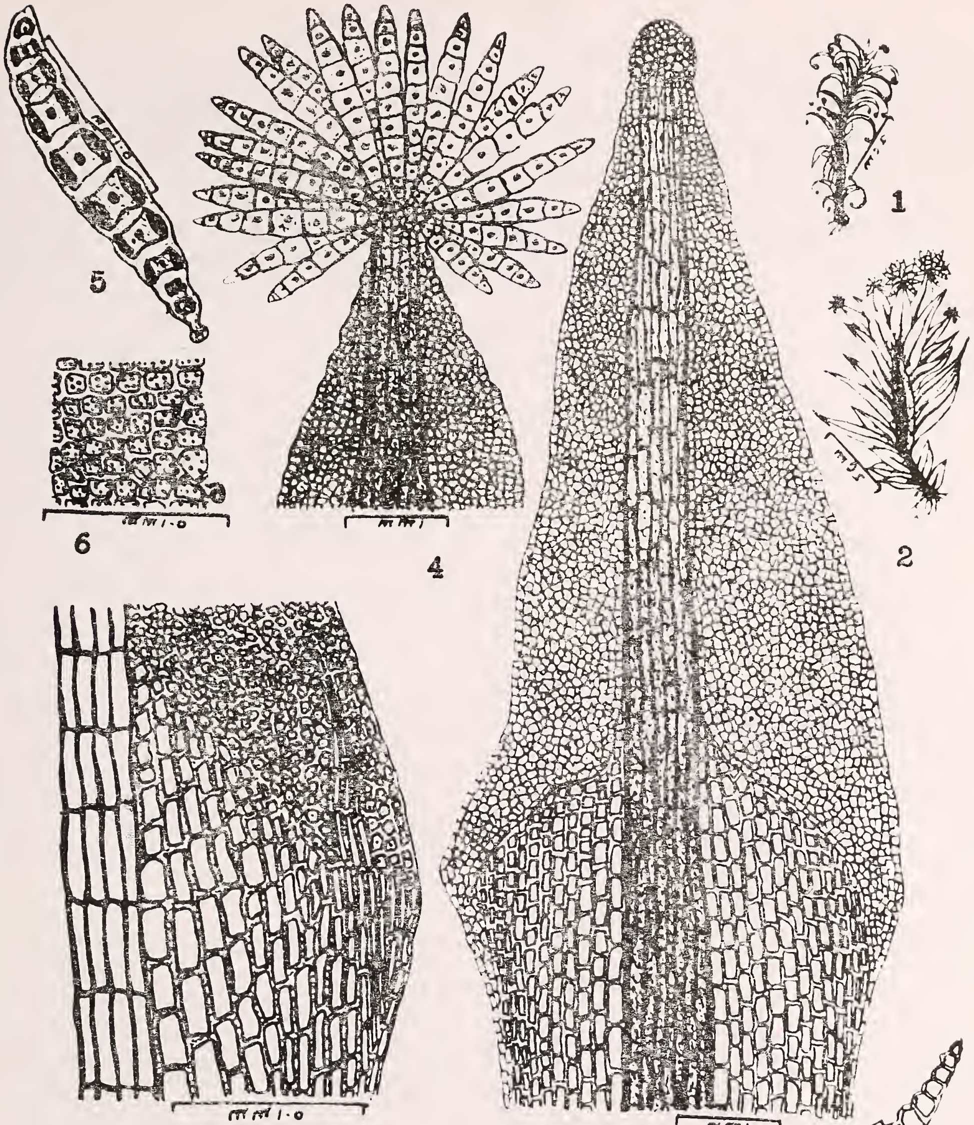
DISCUSSION

In his personal communication to Sr. author, Norkett (1961, 1971) wrote that:

"*Calymperes thwaitesii* Besch. was first recorded by Bescherrle (1895) from Ceylon. Another species, *Calymperes fordii* Fleisch. was also described by Max Fleischer (1904), who is of the opinion that *C. fordii* Fleisch. is very closely related to *C. thwaitesii* Besch. He therefore treated *C. fordii* Fleisch., as a subspecies of *C. thwaitesii* Besch." As this species of *Calymperes* was not recorded so far, this report is considered as a new record from Maharashtra. As *C. thwaitesii* Besch. grows on the coconut and mango trees only around coastal region.

B. N. BANDODKAR COLLEGE OF SCIENCE,
THANE-400 601.
M. D. COLLEGE, BOMBAY-400 012.
March 23, 1988.

G. T. DABHADE
AKHTAR HASAN RIZVI



Calymperes thwaitesii Besch. subsp. *fordii* Fleisch.

1. Showing plant in dry condition; 2. Showing plant in moist condition; 3. Showing cellular structure of the entire leaf; 4. Leaf with cluster of gemmae; 5. Enlarged view of clavate, septate, gemmae with girdle-shaped chloroplast in the cell; 6. Enlarged view of laminar cells; 7. Enlarged view of leaf base showing leaf base cells, teniolae (intra-laminar cells) and laminar cells; 8. T. S. of leaf showing 'deuter, cells in the middle of midrib and laminar cells.

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ERRATA

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MISCELLANEOUS NOTES

On page 268,
Note No. 40, In the Title,

For *Anthraxon* Read *Arthraxon*

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Status of wildlife and habitat conservation in Andhra Pradesh

on Page 611, in Table 3, *Read*

	Name	District	Area Sq Km	In the Year Established	Major animals
3.	Lanjamadugu Sanctuary	„	36	1978	
4.	Nagarjunasagar-Srisailam Sanctuary	Guntur, Prakasam, Kurnool, Mahaboobnagar, Nalgonda	3268	1978	Largest Tiger reserve in India. Tiger, Leopard, Sloth Bear, Wildboar, Spotted deer, Sambar, Nilgai, Chowsingha, Jackal, Fox, Mugger.

MISCELLANEOUS NOTES

34. Two little known flowering plants from Maharashtra

On page 719,

Cassia dimidiata (Buch.-Ham. ex Roxb.) Collett has been reported from Maharashtra However, name adopted for the taxon seems to be a later homonym, as there is already another species known by that name *Cassia dimidiata* D. Don (1825). Correct name for the taxon reported is *Cassia hochestetteri* Chesq. (Bull. Jard. Bot. Brux. 9: 155, 1932). For added synonymy and more details see — Singh, Bull. Bot. Surv. India 18: 87, 1979.

M. R. Almeida

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A CHECKLIST OF THE BIRDS OF HAIGAM RAKH, KASHMIR[1]

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Haigam Rakh is the largest remaining reedbed area in Kashmir. It is maintained by the Jammu and Kashmir Department of Game as a duck shooting reserve, and as such its wintering wildfowl are likely to be well documented. Recent expeditions in July-August, 1978, July-September, 1983 and September, 1984 have shown the area to be of major ornithological importance at other times of the year. Many marshland species breed in the reserve, and the densities of Little Bittern (*Ixobrychus minutus*), Water Rail (*Rallus aquaticus*), Common Kingfisher (*Alcedo atthis*) and Clamorous Reed Warbler (*Acrocephalus stentoreus*) are particularly high. The area is important for autumn migrants, with 45% of the species recorded being passage birds and/or winter visitors. Such species include many waders, wagtails and hirundines which roost in large numbers in the reedbed, and several other short- and long-distance migrants. It is considered that Haigam Rakh is of sufficient ornithological interest to merit further long-term study. We are optimistic that the reserve can be managed so as to maintain its value to the local people, its winter duck shooting and its importance to breeding and migrant birds.

INTRODUCTION

The Vale of Kashmir is a large basin at a height of *c* 1600 m which forms the flood plain of the river Jhelum. It is surrounded by mountains — to the south and west the Pir Panjal Range, to the north the Karakoram and to the east the Ladakh Range. On the side facing the Vale, these mountains are all heavily forested with conifers, although much logging has taken place. The Vale is now largely devoted to agriculture, especially rice paddy and orchards.

The ecology of the Vale has changed markedly since the publication of Bates & Lowther (1952). Haigam (=Hygam) Rakh is the largest remaining reedbed area. Situated at the

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southern end of Lake Wular, the nearest main town is Sopore, but the Rakh is surrounded by villages. It is maintained by the Jammu and Kashmir Department of Game as a duck shooting reserve. The reserve area is about 14 km^2 (Pandit 1982), about 4 km^2 of which is reedbed.

The Rakh is largely covered by a dense growth of reed and other emergent species. The commonest macrophyte species are Common Reed *Phragmites communis,* Bulrush *Typha angustata,* Bur-reed *Sparganium erectum,* club rushes *Scirpus lacustris* and *S. palustris,* Spike Rush *Eleocharis palustris* and sedges *Carex* spp. (Kaul *et al.* 1980, Kaul 1982, 1984). In open areas there are various floating leaf species including the water lilies *Nymphaea stellata* and *N. alba,* Fringed Water Lily *Nymphoides pellata* and Water Chestnut *Trapa natans* (Kaul *et al.* 1980). Vegetation grows either from the bottom of shallower areas or from a floating mat of roots and silt. The reedbed is partitioned by a number of boat channels varying in width from 1 m to 4 m. Water in the Rakh varies in depth up to about 1 m.

The reserve is largely surrounded by a protective bank. Inside this bank, a strip of willows has been planted. These act as a silt trap, but when full grown will also supply the villagers with many useful materials — leaves for cattle feed, sticks and wood. There is no understorey in this plantation since all the lower vegetation is heavily grazed. Outside the bank, and in some places inside, the land is mostly devoted to rice paddy. Slightly further from the bank, at least around Haigam, there are extensive orchards.

Since Haigam Rakh is a shooting reserve the numbers of winter birds (especially ducks) are probably well documented. The first major survey of the summer bird populations of the reedbed was in 1978 (Holmes 1978). Since then, various studies have been carried out at Haigam, including studies of the trophic structure (Pandit & Kaul 1981), production (Kaul 1982), freshwater snail ecology (Kaul *et al.* 1980) and feeding ecology of breeding birds (Pandit 1982).

It has become apparent that the Rakh is a very rich area, and is of major ornithological interest, not only for its wintering wildfowl but also for its breeding birds and for the large number of species that visit the site on migration. Until now, there has been little published detailed information on the avifauna of Haigam Rakh. The purpose of the present article is to rectify this, so as to provide a broader understanding of the ecology of this key wetland site.

The results presented here are a compilation of the results of expeditions to Haigam Rakh in 1978 (Holmes 1978) and 1983 (Holmes *et al.* 1983), together with some unpublished records for 1984 kindly provided by Peter Burns and Frances Goodwin. The periods of study were:

1978	9 July to 20 August (5 people)
1983	13 July to 20 August (5-7 people) 17-23 September (1 person)
1984	14-30 September (2 people)

All the expeditions have been based in Hanjypura village, on the western edge of the Rakh, where facilities were generously provided for us by the Kashmir Department of Game. As well as general observation, much time was devoted to ringing birds using the Rakh. Mist nets were set both along the boat channels in the main reedbed area, where they had to be erected and operated from punts, and along the Rakh edge. At the Rakh edge, nets were set both in the willow plantation and on an area (approximately 3 ha) of flooded grassland near Hanjypura, referred to as “the pond”.

The following is a list of species recorded at Haigam Rakh. Several species for which we consider the records doubtful, have been omitted.

Status Code : B = Confirmed breeding
S = Suspected breeding
P = Passage migrant/ Winter visitor
U = Status uncertain

Tachybaptus ruficollis. Little Grebe (B)

Fairly common in the more open areas of the Rakh.

Ixobrychus minutus. Little Bittern (B)

Abundant in July/August. Only one confirmed sighting in September, an immature on 29/9/83.

Nycticorax nycticorax. . Night Heron (S)

Often seen in small numbers flying over the Rakh, or sometimes in paddies, in the evening. Maximum in 1978 10, in 1983 5 on 27/7 (4 juveniles) and 9/8 (3 juveniles).

Ardeola grayii. Paddybird (U)

Singles recorded on 15/7/78, 18/7/78 and and 10/7/83; the 1983 record was on the pond.

Egretta garzetta. Little Egret (U)

Recorded on the pond in 1983, with 2 on 13/8, then 1-2 daily until 20/8.

Egretta sp. (U)

Unidentified egrets were recorded on 18/7/83 (3 flying over) and 19/7/83 (single).

Ardea cinerea. Grey Heron (S)

Common. Regular activity in one area of the Rakh suggested reed-bed nesting. Up to 14 present on the pond at dawn on most days in 1983.

Anas platyrhynchos. Mallard (P)

Records of several on 26-27/7/78 and 2 on 15/8/83.

Anas acuta. Pintail (P)

Small numbers recorded in 1978 from 29/7.

Anas crecca. Teal (P)

The only confirmed records were a single on 19/9/84 and 2 on 21/9/84.

Anas querquedula. Garganey (P)

A single recorded on 19/9/84.

Anas sp. (P)

Records of unidentified ducks in 1978 comprised singles on 24/7, 26/7, 4/8 and 14/8, and a flock of *c* 50 on 19/8, all either Teal or Garganey, plus a flock of *c* 30 on 13/8. The only unidentified duck records in 1983 were a single on 8/8 and 3 on 14/8, all probably Mallard or Pintail.

(Aythya nyroca. Ferruginous Duck (Formerly B)

Recorded as breeding at Haigam by Bates & Lowther (1952), but not seen in 1978 or 1983.)

Milvus migrans. Black Kite (B)

Common. Occasionally recorded fishing. In 1978 a pair nested in Hanjypura village.

Circus aeruginosus. Marsh Harrier (P)

1-2 female/immatures seen regularly over the Rakh in 1983, from 7/8 to 20/8, with 4 present on 17/8. Seen daily in 1984, with a maximum of 6 on 14/9.

Accipiter gentilis. Goshawk (P)

Singles recorded on 18/9, 23/9 and 28/9/84.

Falco subbuteo. Hobby (U)

Occasional records in 1983 of singles, often hunting in the swallow roost. In 1984 singles recorded on 23/9 and 28/9.

(Raptor sp.) (U)

In 1983 single large unidentified raptors were seen over the Rakh on four occasions during July, and on 23/9.

Rallus aquaticus. Water rail (B)
Abundant in the Rakh.

Porzana pusilla. Baillon's Crake (S)
Heard in the Rakh fairly frequently, and occasionally seen.

Porzana fusca. Ruddy Crake (S)
Trilling calls heard from rice paddy at dawn on several dates in 1983. At least 4 individuals present.

Gallinula chloropus. Moorhen (B)
Common in the Rakh in summer. In 1984 recorded on 28/9 (2) and 30/9.

Porphyrio porphyrio. Purple Gallinule (Formerly S)
Recorded by Bates & Lowther (1952), but not seen during the recent studies.

Hydrophasianus chirurgus. Pheasant-tailed Jacana (B)
Small numbers bred in 1978. In 1983 occasional records July, regular during August with up to 3 birds on flooded pasture at the edge of the Rakh. Probably a nest/young nearby. Numbers have declined since 1978, probably due to the increase in reed cover; at Hokasar in 1983 the species was common.

Rostratula benghalensis. Painted Snipe (S)
Two were trapped on 20/8/78. In 1983 4 records of 1-2 birds at the edge of the Rakh. included a male ringed on 2/8. Observed at dawn and dusk only.

Himantopus himantopus. Black-winged Stilt (P)
One record in 1978 of a single on 21/8. In 1983 1-4 on the pond on most days from 5-19/8, then 22 on 20/8. In 1984 singles recorded on 21/9 and 28/9.

Recurvirostra avosetta. Avocet (P)
One called in briefly at the pond on 15/8/83.

Charadrius dubius. Little Ringed Plover (U)
A possible family party was seen on the pond intermittently during late July-August 1983.

Pluvialis dominica. Lesser Golden Plover (P)
An adult still in partial summer plumage was seen on the pond on 18/8/83.

Vanellus indicus. Red-wattled Plover (U)
One heard at the edge of the Rakh on 2/8/83.

Calidris minuta. Little Stint (P)
Often a few on the pond with *C. temminckii* during late July-August, with a maximum of 20 on 26/7/83 when few *C. temminckii* were present.

Calidris temminckii. Temminck's Stint (P)
Common on the pond during late July-August. Often 30+ present. Present 26-30/9/84, with a maximum of 10 on 28/9. Several small waders present between 17-20/9/83 were probably this species.

Calidris ferruginea. Curlew Sandpiper (P)
One on the pond from 2-5/8/83.

Philomachus pugnax. Ruff (P)
Four seen on the pond after heavy rain on 23/7/83. One present on 28/9/84.

Gallinago gallinago. Common Snipe (U)
A single trapped on 29/9/84.

Gallinago sp. (U)
Single unidentified snipes, either Common Snipe or Pintail Snipe (*G. stenura*), were recorded in 1978 from 14/8, occasionally drumming. In 1983 singles were seen flying over the Rakh on 27/7, 17/9 and 19/9, Up to 3 were present in September 1984.

Scolopax rusticola. Woodcock (P)
One on 17/8/78.

Tringa erythropus. Spotted Redshank (P)
An adult still in partial summer plumage flew over the Rakh on 13/8/83.

Tringa totanus. Redshank (P)
In 1978 2 recorded on 15/8. In 1983 13 flew over on 14/7 and records from the pond were one on 10/8 (ringed), 2 on 18/9 and one on 19/9.

Tringa nebularia. Greenshank (P)
Many records of singles during July/August, with 3 on 23/7/83. In 1984 singles were recorded on 16/9, 19/9 and 20/9/84.

Tringa ochropus. Green Sandpiper (P)
In 1978 3 were present on 13/8. In 1983 one on the pond on 15/8. In 1984 1-2 present daily from 23-30/9.

Tringa glareola. Wood Sandpiper (P)
Regular in small numbers on the pond from the last week of July to August. Largest numbers were 10 on 24/7/83 (flying over) and on 26/7/83. In 1984, 3-5 recorded daily from 21-30/9.

Tringa terek. Terek Sandpiper (P)
One caught before dawn on 21/8/78.

Tringa hypoleucos. Common Sandpiper (P)
In 1978 singles recorded on 8/8, 11/8, 17/8. In 1983 1-2 daily during August, on the pond, or other wet pasture. One present on 19/9/84.

Chlidonias hybrida. Whiskered Tern (B)
A common breeder in the Rakh. In 1978 there were about 30 pairs in 2 small colonies. In 1983 a maximum of 40 adults was seen on 28/7; fledged juveniles were recorded from 25/7 onwards.

Streptopelia orientalis. Rufous Turtle Dove (P)
A roost of up to 100+ present at the end of September 1984.

Streptopelia decaocto. Ring (Collared) Dove (B)

Common, feeding on dry paddies. *c* 300 on 23/9/83.

Psittacula himalayana. Slaty-headed Parakeet (U)

A roost was present in trees at the edge of the Rakh. Up to 100+ were seen flying over at dusk.

Cuculus canorus. Eurasian Cuckoo (S)
In 1978 adults were recorded calling until 11/8, with juveniles seen on 22/7 and 13/8. In 1983 there were several sightings of juveniles in July.

Strix aluco. Tawny Owl (U)
One heard calling on 15/7 and 16/8/78. An owl seen in 1983 (date not recorded) was probably this species.

Ceryle rudis. Lesser Pied Kingfisher (S)
Nearly daily sightings. In 1978 up to 4 seen, possibly a family party. In 1983 a family party of male, female and 4 young seen 11/8. A maximum of 3 recorded in September 1984.

Alcedo atthis. Common Kingfisher (B)
Abundant in summer, nesting in the earth banks around the Rakh. In 1983 still common in mid-September, but in late September 1984 the maximum daily total recorded was 3.

Pelargopsis capensis. Brown-capped Stork-billed Kingfisher (U)
One recorded on 16/8/78 could have been the same individual recorded by a WWF party at Hokasar, another game reserve.

Halcyon smyrnensis. White-breasted Kingfisher (S)
1-2 seen regularly.

Merops apiaster. European Bee-eater (U)
In 1978 a large passage of 50+ birds was recorded on both 19/8 and 20/8. In 1983 20-30 were seen in mid-July, feeding over the pond and paddies. One was seen on 31/7, then recorded regularly from 13-20/8 with a maximum of *c* 30. In 1984 recorded on 14/9 (10+) and 18/9.

Coracias garrulus. European Roller (B)

Seen in small numbers at several sites during July and August. Nine present on 17/9/84.

Upupa epops. Hoopoe (S)

Initially common; numbers declining during August, but singles still present on 19/9 and 23/9/83, and between 14-30/9/84.

Jynx torquilla. Wryneck (U)

In 1978 one was seen on 21/8. In 1983 one was caught in the plantation on 13/8 in the early stages of moult, and retrapped in the same site on 19/9 still in moult.

Picoides auriceps. Brown-fronted Pied Woodpecker (S)

In 1978 recorded on 3/8 and 17/8. In 1983 fairly regular sightings of singles in willows around the Rakh. One male was trapped 15/8. In 1984 singles were recorded on 17/9, 19/9 and 27/9.

Picoides himalayensis. Himalayan Pied Woodpecker (U)

In 1983 singles were recorded in willows on 29/7 and 5/8.

Picus squamatus. Scaly-bellied Green Woodpecker (U)

In 1978 singles were recorded on 16/7, 20/7, 28/7 and 13/8. Only one record from 1983, of a single seen over the Rakh on 31/7.

Riparia paludicola. Indian Sand Martin (P)

All *Riparia* sp. identified were this species. Fairly common amongst Swallows at roost in July and August; a few feeding during the day over the Rakh. Largest catch of 24 on 30/7/83. Small numbers (5+) recorded in late September 1984.

Hirundo rustica. Swallow (B, P)

Breeds in houses in Hanjypura village. Large roost of several thousand near edge of Rakh; numbers slowly decreasing during August. A small roost was still present in mid-September 1983. In 1984 30+ recorded on 14/9 decreased to the last sighting of 2 on 28/9. Most adults, and many juveniles, were in moult, with the moult score increasing as the autumn progressed. This is in contrast to western *H. rustica rustica* (the same subspecies) which do not moult until they reach the winter quarters (Ginn & Melville 1983).

Anthus trivialis. Tree Pipit (P)

One caught at the edge of the Rakh on 19/9/83. Three pipits seen on 23/9/83 were possibly this species.

Anthus sp. (U)

Unidentified pipits were seen on 25/7/78 (2) and 28/9/84.

Motacilla citreola. Citrine Wagtail (S, P)

Fewer than *M. alba* during early July, but increasing from the last week of July to become the commoner wagtail. In 1978 a large roost was present near the pond from mid-August; in 1983 this roost was somewhat smaller and formed later. Some individuals trapped were in a very worn juvenile plumage, usually with a brood patch. It is thought that these were mostly first summer females which, for some reason, had not moulted into adult plumage. Ali & Ripley (1983) state that some first summer males breed in the juvenile plumage. A second year male ringed on 21/8/78 was retrapped on 25/9/84.

Motacilla cinerea. Grey Wagtail (P)

Singles recorded on five dates between 15-28/9/84.

Motacilla alba. Pied Wagtail (S, P)

Relatively few were present in early July, but numbers increased during late July and August, with many still present in September. Mainly seen by the pond.

Pericrocotus ethologus. Long-tailed Minivet (U)

Uncommon; only recorded in 1983. Two present in willows on 10/7, and a few later records during July/August.

Pycnonotus leucogenys. White-cheeked Bulbul (B)

Common around habitation.

Erithacus svecicus. Bluethroat (P)

The earliest record was on 8/8/83 (an adult male), with numbers building up rapidly during mid-August. Abundant during September. Occupied both the middle of the Rakh and the willows around the edge. In 1984 became more abundant towards the end of September.

Saxicola torquata. Collared Bush Chat (Stonechat) (P)

A male was seen in the Rakh on 15/8/83. Two were present on 23/9/83.

Saxicola caprata. Pied Bush Chat (U)

An adult female with a brood patch was trapped in the Rakh on 24/7/83.

Turdus unicolor. Tickell's Thrush (B)

Common around the Rakh in summer. Only one record in 1984, on 23/9.

Hippolais caligata rama. Syke's Warbler (P)

A yearling was trapped on 16/8/78.

Acrocephalus concinens. Swinhoe's Reed Warbler (B)

Breeds in small numbers in the Rakh, often near isolated willows. About 10 territories found. Fledged young were caught on 29/7 and 14/8/83. Only caught in the Rakh.

Acrocephalus agricola. Paddyfield Warbler (P)

A yearling was caught in the Rakh on 17/8/83.

Acrocephalus dumetorum. Blyth's Reed Warbler (P)

A yearling was caught in the plantation on 13/8/83.

Acrocephalus stentoreus. Clamorous Reed Warbler (B)

An abundant breeder in the Rakh. Many individuals feed in the willows around the edge of the reeds. Two adults (one male, one female) ringed in 1978 were retrapped in 1983. Very few were present from 17-20/9/83, and in 1984 the only record was of 2 on 14/9.

Sylvia curruca. Lesser Whitethroat (P)

One trapped in the plantation on 19/9/83.

Phylloscopus collybita. Chiffchaff (P)

In 1984 2-3 recorded daily from 24-30/9, with 6 ringed.

Phylloscopus sindianus. Mountain Chiffchaff (P)

Recorded on 29/9 and 30/9/84, with a total of 4 trapped.

Phylloscopus inornatus. Yellow-browed Warbler (P)

Singles were caught in the plantation on 18/9 and 19/9/83, and 20/9 and 30/9/84.

Phylloscopus trochiloides. Greenish Warbler (P)

In 1978 4 individuals trapped, on 10/8, 13/8, 18/8 and 19/8 (2 present). In 1983 single yearlings were trapped in the plantation on 16/8 and 18/9. One was trapped on 26/9/84.

Phylloscopus sp. (U, P)

An unidentified leaf warbler was seen in the willows on 20/7/78. Several unidentified *Phylloscopus* warblers were seen during mid-September 1983.

Muscicapa superciliaris. White-browed Blue Flycatcher (P)

A juvenile male was trapped in the plantation on 18/9/83. A female was trapped on 19/9/84 and was still present on the next two days, and a juvenile male was trapped on 22/9/84.

Terpsiphone paradisi. Paradise Flycatcher (B)

Seen daily during July and August. Present in two sites at the edge of the Rakh, and in Hanjypura village. At one site on 12/7/83 a breeding male was seen with a female and a first/second summer male, suggesting co-operative breeding. One still present on 20/9/84.

Parus major. Grey Tit (B)

Common, with several family parties caught.

Certhia sp. (P)

A treecreeper was recorded in September 1984 (exact date not recorded). It is likely that this was a Himalayan Treecreeper, *C. himalayana.*

Oriolus oriolus. Golden Oriole (B)

Common in mature trees around the Rakh. Still present in mid-September 1983.

Lanius schach. Rufous-backed Shrike (B)

A common breeder around the Rakh. One was seen feeding a cuckoo fledgling on 24/7/83. The only records in 1984 were singles on 15/9 and 26/9.

Dicrurus adsimilis. Black Drongo (U)

Singles were recorded on 17/7/78, and in Hanjypura village on 18/9/83.

Corvus splendens. House Crow (S)

Common. Often seen in the Rakh itself.

Corvus macrorhychos. Jungle Crow (U)

Two records in July 1983.

Corvus monedula. Jackdaw (S)

Fairly common, with a maximum of 33 recorded on 23/9/84.

Sturnus vulgaris. Starling (S)

Fairly common. A flock of *c* 150 present on 4/8/83, and 50+ recorded on 14/9/84.

Acridotheres tristis. Common Myna (B)

Fairly common.

Passer domesticus. House Sparrow (B)

Very common. Large flocks (up to 700+) were recorded feeding in paddies.

Lonchura punctulata. Spotted Munia (U)

A single was trapped on 11/8/78.

Carduelis carduelis. Eurasian Goldfinch (P)

A party of 5 was recorded on 19/8/83.

Carpodacus erythrinus. Common Rosefinch (P)

In 1978 an adult male was trapped on 16/8. In 1983 a medium-sized flock was present in the plantation during mid-September, with 39 caught in two days. Four individuals recorded on 22-23/9/84.

Discussion

The list of 92+ species of birds recorded at Haigam is undoubtably incomplete, especially since so little study has been undertaken during migration periods (none at all in spring). Many of the forest breeding altitude migrants will probably be recorded in due course, as well as additional trans-Himalayan migrants. Similarly, although we have not had access to official figures, the variety of ducks using the site in winter must exceed that recorded here. There are also likely to be species other than waterfowl wintering in the reserve area.

Our studies have demonstrated that the ornithological importance of Haigam Rakh extends beyond its winter wildfowl. There are very high densities of several breeding marshland birds, e.g. Little Bittern, Water Rail, Kingfisher and Clamorous Reed Warbler. There are also significant populations of Baillon's Crake, Whiskered Tern and the very local Swinhoe's Reed Warbler. In addition, the area is important as a feeding area for large numbers of migrants which pass through in autumn. This includes an impressive variety of waders, and also both short and long distance passerine migrants. The area may be particularly important to long distance migrants, providing a feeding and stopping-off site after the rigours of a trans-Himalayan crossing. Large numbers of hirundines and wagtails also use the Rakh as a roosting and moulting area.

We consider the Rakh of sufficient interest for it to be of benefit to establish there a permanent ringing station, to continually monitor the number of birds visiting the site.

There is an increasing awareness in Kashmir of the need to preserve the local environment. This is not just for the welfare of the wildlife, but also for more practical reasons. If Haigam Rakh was not a reserve, it would quickly be drained for paddy, and some encroachment has already taken place. At present the Rakh has many uses apart from its value as a source of income to the Game Department from the shooting. Local people harvest the reeds for thatching and mat-making. The vegetation is used as cattle feed, with the cattle sometimes driven into the Rakh itself to feed. Villagers catch fish in the open water areas. The willows planted around the edge, as well as acting as a silt trap, will in due course be a source of firewood for the local people. As well as this, the shooting provides employment for many local people, as guards, boatmen and general labourers.

The Rakh has three very important functions. It is a large area of renewable resources, providing a living to many local people. It is a well-managed shooting reserve, providing income to the Department of Game. Finally, but equally important, it is an area of outstanding conservation interest. With strict management there is no reason why there should be a conflict between these functions. Indeed, if the Rakh disappeared through siltation and conversion to agriculture this would be detrimental to local interests as well as to the conservation and shooting interests. However, for management and conservation to be effective, the co-operation and goodwill of the local people is essential.

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BIOLOGICAL ASPECTS OF TWO SPECIES OF GERRIDS, *LIMNOGONUS FOSSARUM FOSSARUM* FABR. AND *LIMNOGONUS NITIDUS* MAYER (HEMIPTERA: HETEROPTERA)[1]

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(*With two text-figures*)

Biological notes on two gerrid species, *Limnogonus fossarum fossarum* Fabr. and *Limnogonus nitidus* Mayr. are given. The number of eggs laid by a single individual, duration of incubation, preoviposition period and the duration of each instar were analysed. Allometric growth with reference to leg segments and antennal segments in relation to body length in two species are also analysed. The results of the findings in relation to the ecological factors are discussed.

INTRODUCTION

The diversity of form and structure in different species of the gerrid group provides interesting information, especially from the point of view of their relation to environment. Hoffmann (1936) has made notable contributions to the bionomics of *Limnogonus fossarum* Fabricius from Canton. Cheng (1967) and Andersen (1975) studied *Limnogonus fossarum* with particular reference to its feeding habits. Since no comparable accounts on the biology of gerrids from India are on record, an attempt has been made here to study the biology of the two related species, *Limnogonus fossarum fossarum* Fabr. and *Limnogonus nitidus* Mayr.

MATERIAL AND METHODS

Limnogonus fossarum fossarum is commonly found in small ponds, pools, ditches, paddy fields and channels. *Limnogonus nitidus* is encountered in water pools around Loyola College campus at Madras; it prefers the edges of water, darting into open water at the slightest disturbance. Specimens of *L. f. fossarum* were collected from different types of freshwater habitats in the vicinity of Madras, namely, a perennial pond in Chetpet, a temporary pond in Meenampakkam, besides water puddles and paddy fields in and around Madras. Specimens of *L. nitidus* were collected from temporary pools adjacent to the college campus. After collection, the adults were separated from the nymphs. In the laboratory, the specimens were reared in glass aquaria of 22×15×12 cm, half filled with water. Aquatic plants *Hydrilla, Eichhornia* and *Lemna* were kept in the aquaria to provide natural conditions to the extent possible. The insects were regularly fed with mosquito larvae and nymphs of *Notonecta*. The aquaria were kept under regular observation, and the number of eggs deposited was counted. When the eggs hatched, the nymphs were isolated in order to avoid mortality, caused mainly by cannibalism, and fed regularly with the early nymphs of *Notonecta*.

OBSERVATIONS

Feeding habits: In the field, *Limnogonus fossarum fossarum* and *Limnogonus nitidus*

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feed on dead or dying animals such as *Notonecta*, dragonfly naids, Dilphium, larval forms of dipterans and ephemerids, they show a preference to nymphs of *Notonecta*, as observed under laboratory conditions.

Copulation: Copulation occurs during the rainy months of the year when several pairs of both the species under study are seen on the surface water in copula. In both the species, the opposite sexes face the same direction when in copula. When disturbed, the copulating pairs move away slowly without getting detached. Copulation has been seen to last about 35-45 minutes in *L. f. fossarum* and 15-20 minutes in *L. nitidus*.

Preoviposition period: In both the species, the preoviposition period is influenced by temperature. In *L. f. fossarum*, eggs are laid 8-10 days after copulation when the ambient temperature is 28°-29°C, whereas in *L. nitidus* the preoviposition period is shorter, being 5-6 days; in both species, the preoviposition period appears to extend over 20-25 days when the temperature is low (22°-24°C).

Oviposition: Gerrids lay their eggs on floating or submerged plants or any material which is accessible on the surface of water, and the two species studied here are no exception. The eggs are laid in a linear fashion in two or three rows on the plants. In the laboratory, however, both the species have been observed to show a preference to *Hydrilla* plants for oviposition. During oviposition, a gelatinous substance flows out and forms a sort of protective covering besides serving to glue the eggs to the surface of the objects on which the eggs are laid. On one occasion, *L. f. fossarum* was noticed to oviposit on a live specimen of *Ranatra filiformis*. Both the species studied here have been found to lay eggs at night. *L. f. fossarum* lays 40-48 eggs at a time, while *L. nitidus* lays a much lower number, viz. 20-25 at a time.

Fecundity: Under laboratory conditions, observations on four female *L. f. fossarum* maintained for six months revealed that the maximum number of eggs was 179. In their natural habitat, the incidence of eggs as shown by field collections is very high during the rainy months of November and December, in January and February the number of eggs declines gradually, and after March very few eggs are encountered, apparently due to the gradual drying of the media. However, even under the nearly constant conditions of the laboratory, the ovipositing rhythm appears to continue as it is in the natural habitat. The eggs laid during November and December are found to be much more numerous than in the subsequent months. (Tables 1, 2). In *L. nitidus* the total number of eggs laid was 99 in November, 1977, and declined to 35 in March, 1978.

Eggs: In both the species, the eggs are small and white in colour at the time of deposition, subsequently changing to yellow to brown. On an average, the eggs of *L. f. fossarum* measure 0.93 mm. long and 0.24 mm. wide. The eggs of *L. nitidus* show wide variation in dimensions and, on an average, measure 1.86 mm. in length and 0.62 mm. in width.

Incubation: It has been observed that temperature has a significant effect on incubation period. In *L. f. fossarum*, the incubation period is 6-10 days when the temperature is 29°-32°C. In the present study, the upper limit for hatching was 31°-32°C, and no hatching occurred below 22°C. In *L. nitidus*, the incubation period is 5-8 days when the temperature is 29°-31°C. The five-day old embryonated eggs of *L. f. fossarum* show a pair of brown spots indicating the compound eyes, and these spots appear 6-7 days after oviposition in the case of *L. nitidus*. The Y-shaped egg-burster present in both the species of gerrids under study, helps in the hatching process (Table 3).

TABLE 1

TOTAL NUMBER OF EGGS COLLECTED FROM THE NATURAL HABITATS IN DIFFERENT MONTHS OF THE YEAR 1977-78

Habitat	November 1977	December 1977	January 1978	February 1978	March 1978
Redhills lake	638	590	540	470	210
Chetpet pond	425	401	380	302	120
Meenampakkam pond	230	220	198	120	60
Water puddles	75	40	20	7	—
Total	1368	1251	1138	899	390

TABLE 2

EGG-LAYING CAPACITY IN FOUR FEMALES OF (1) *Limnogonus fossarum fossarum*, AND (2) *Limnogonus nitidus* UNDER LABORATORY CONDITIONS

	Female No.	Number of eggs laid in each month				
		November 1977	December 1977	January 1978	February 1978	March 1978
Limnogonus fossarum fossarum	I	48	45	40	31	13
	II	43	40	28	25	10
	III	50	42	39	30	18
	IV	49	40	22	18	12
Total number of eggs		190	167	129	104	53
Limnogonus nitidus	I	23	25	21	20	9
	II	25	25	26	22	10
	III	25	23	22	20	8
	IV	26	24	18	20	8
Total number of eggs		99	97	87	82	35

TABLE 3

RECORD OF OVIPOSITION AND PERIOD OF INCUBATION IN (1) *Limnogonus fossarum fossarum* AND (2) *Limnogonus nitidus*

	No.	Number of eggs	Laid on	Hatched on	Incubation period in days	Temperature
	1	48	7.11.77	17.11.77	10	29.5°C
	2	38	18.11.77	28.11.77	10	29.5°C
	3	25	20.11.77	29.12.77	9	28.7°C
Limnogonus	4	28	3.1.78	11.1.78	8	29.8°C
	5	25	5.2.78	13.2.78	8	31.0°C
fossarum	6	12	8.3.78	14.3.78	6	32.0°C
fossarum	7	10	15.3.78	21.3.78	6	32.0°C
	1	30	8.11.77	16.11.77	8	29.1°C
	2	28	20.11.77	28.11.77	8	29.1°C
	3	25	10.12.77	17.12.77	7	30.0°C
Limnogonus	4	20	5.1.78	11.1.78	6	30.5°C
nitidus	5	20	13.2.78	19.2.78	6	30.5°C
	6	15	7.3.78	12.3.78	5	31.0°C
	7	10	16.3.78	21.3.78	5	31.0°C

Hatching: Hatching is initiated by the contraction and relaxation of the embryo, as a result of which a pressure is developed inside the egg, and the first instar nymph emerges by making a longitudinal slit about two thirds of the length of the egg from the egg-burster.

As it comes out of the egg shell, the first instar nymph goes down to about 10 cm under the water surface and then it rises to the surface by spreading its second and third pairs of legs; it slowly flexes its legs and starts to stride on the water surface. The first instar nymphs show a very high mortality rate if the water in the rearing jar is not changed frequently.

Moulting: Each moulting appears to be a critical period for the instar because mortality is high during this period. During moulting, the cuticle begins to split from the head region and the Y-shaped split which extends to the middle region of the thorax broadens. Nymphal instars have a preparatory period for moulting, during which they are sluggish and always attached to floating aquatic plants or at the margins of the medium. The animal first pulls out its head, followed by the forelegs and then the whole body; it remains motionless for about 30-40 minutes. The exuvia are discarded or pushed away by the forelegs which remain as a float on the water surface. The body pigmentation occurs only after 24 hours, and then the insect moves away for feeding.

Sexual maturity: In *L. f. fossarum* at a temperature of 28°C, 8-10 days are required to attain sexual maturity after the final moult and this period is reduced to 5-7 days if the temperature rises to 31-32°C. In *L. nitidus* it requires 6-9 days at 29-30°C. and 5-7 days at 32-33°C.

Immature stages:

There are five nymphal instars in both the species studied. Though the nymphal instars do not display any distinctive morphological characters to differentiate the successive nymphal stages, morphometric analysis of the linear measurements of body, antennae and legs, besides head width, is of value to distinguish one nymphal stage from the other (Tables 4, 5).

TABLE 4

MORPHOMETRIC ANALYSIS OF *Limnogonus fossarum fossarum* (MEASUREMENTS IN MM.)

Instar	Body total length	Head length	Head width	Rostrum length	Antenna length	Fore leg length	Middle leg length	Hind leg length
I	1.662± 0.21	0.252± 0.16	0.460± 0.13	0.931± 0.46	1.261± 0.14	0.963± 0.23	1.867± 0.73	1.520± 0.61
II	2.467± 0.12	0.453± 0.14	0.613± 0.14	1.101± 0.63	1.957± 0.38	1.60± 0.52	5.069± 0.47	3.228± 0.35
III	0.698± 0.82	0.605± 0.69	0.765± 0.12	2.126± 0.27	2.561± 0.92	2.033± 0.33	6.003± 0.46	3.85± 1.4
IV	6.360± 1.72	0.832± 0.25	1.172± 0.85	2.561± 0.25	3.928± 0.62	3.260± 0.14	10.53± 1.26	6.41± 1.21
V	7.54± 1.65	0.952± 0.31	1.367± 0.85	2.963± 0.82	5.083± 0.12	4.789± 0.11	13.43± 1.27	10.05± 1.68
Adult female	9.925± 1.32	1.171± 0.32	1.814± 0.42	3.08± 0.31	6.474± 0.27	6.109± 0.19	17.903± 2.39	14.96± 2.75

TABLE 5

MORPHOMETRIC ANALYSIS OF *Limnogonus nitidus* (MEASUREMENTS IN MM.)

Instar	Body length	Head length	Head width	Antenna length	Foreleg length	Midleg length	Hindleg length
I	0.80± 0.12	0.35± 0.10	0.24± 0.13	0.84± 0.31	0.83± 0.42	2.09± 0.32	1.23± 0.65
II	1.2± 0.12	0.42± 0.14	0.29± 0.11	1.27± 0.27	1.04± 0.31	2.72± 0.25	1.65± 0.72
III	2.0± 0.21	0.58± 0.16	0.42± 0.25	1.83± 0.28	1.35± 0.14	3.30± 0.31	2.32± 0.38
IV	3.4± 0.52	0.85± 0.46	0.62± 0.24	2.33± 0.16	2.30± 0.31	4.90± 0.14	3.60± 0.36
V	6.0± 0.13	1.14± 0.25	0.80± 0.31	2.86± 0.18	3.30± 0.14	7.10± 0.19	5.14± 0.14
Adult female	9.0± 0.75	1.4± 0.32	1.1± 0.12	5.15± 0.13	4.48± 0.21	12.40± 0.27	9.20± 0.26

Description of immature stages:
Limnogonus fossarum fossarum

First instar more or less translucent soon after hatching, but turning to brownish after a day; head wider than long, appendages very thin, smooth; rostrum 4-segmented, antennal 4th segment longest, twice as long as 3rd segment; duration about 7 days.

Second instar a little more brownish than the preceding stage; head 1.3 times as wide as long; pronotum with two brownish patches; appendages weakly chitinized; rostrum extending up to mesothorax; antenna one and a half time longer than that of first instar; middle and hind legs hairy; abdomen brown; duration of this stage 8 days.

Third instar light brown; head about 1.25 times wider than long; first segment of antenna shortest; fourth segment longest; head with three stripes just appearing; two brown patches distinctly visible on the pronotum showing a tendency to fuse; dorsolateral aspects of thorax and abdomen with dark patches; rostrum nearly twice as long as that of second instar; antenna about 1.3 times longer than in the preceding stage; duration 8.5 days.

Fourth instar, with head nearly one and a half times as wide as long; the fused pronotal patches darker and broader; extending upto metanotal region; rostrum about 2.75 times longer than that in first instar; antenna about twice as long as that of first instar; body nearly four times longer than first instar; dark brown; duration 8.5 days.

Fifth instar, with head nearly 1.5 times broader than long; fourth segment of rostrum darker than rest of head, with serrated tip; antenna nearly 1.3 times longer than that of fourth instar; the fused dark patches on pronotum extending laterally; abdominal patches darker; duration 9.5 days.

Adult (winged female): dark brown marooned with black; body length 9.9 mm. Head protruding well beyond eyes, with a broad central and narrow lateral black stripes; anterior lobe of pronotum with two yellow spots, one on each side of median longitudinal line; ventral aspect of mesosternum nearly white with a brown central patch; antenna brown, four-segmented; rostrum strong, last segment very dark; foreleg light brown, distal end spinous, tibia shorter than femur, tarsal claws arising from apical one-third of 2nd tarsomere; middle legs with femora and tibiae light brown, beset with numerous spines; tarsus dark with shades of brown; hind legs shorter than middle legs, femora and tibia spiny; wings dark brown, extending beyond tip of abdomen.

Limnogonus nitidus

First instar light brown, pubescent, eyes light reddish; antenna four-segmented, terminal segment longest; rostrum short, four-segmented, terminal segment dark; tarsi one-segmented; abdomen very short due to the telescoping of the terminal segments in early first instars; later, the segments getting distended; duration 6-7 days.

Second instar, with general coloration brown, head broader than long; eyes rounded and prominent; prothroax distinct and distinguished by a pair of dark patches on the pronotum, mesonotum and metanotum; terminal abdominal segments well distended; duration 6-7 days.

Third instar, with general coloration as in second instar, eyes darker than in preceding stage; rostrum extending as far backwards as prothorax; presumptive areas of wing pads indicated; duration 4-6 days.

Fourth instar, dark brown; head much wider than long; pigmented patches on meso- and meta-notum covered by wing pads; wing pads reaching as far as bases of hind legs; duration 6-7 days.

Fifth instar, with general coloration dark with shades of brown; rostrum extending up to mid-coxae; wing pads dark, distinct and extending beyond third abdominal segments; mid- and hind pairs of legs extremely long, their femora extending far beyond the tip of abdomen; duration 7-8 days.

Adult (winged female): General coloration predominantly black, lustrous; body length 9.0 mm. Head typically with a pair of yellow longitudinal stripes; pronotum with a pair of median longitudinal yellow stripes and a pair of yellow spots on either side of the median stripes; antenna four-segmented; rostrum strong and short; forelegs light brown with their tibiae longer than tarsi; middle legs light brown; hind legs dark brown.

Allometric growth: During the study of structural evolution, it has become increasingly apparent that the proportional lengths of legs and antennal segments alter with change in body size. The proportional length of antennal and leg segments vary ontogenetically among the adults of different sizes. Since the length of antennal and leg segments is more constant than the body size among individuals at each stage, allometric growth is usually studied in relation to antennae and leg segments (Hungerford & Matsuda 1960). Hence the lengths of segments are more reliable criteria in deciding the stages of development than the body sizes. Hemimetabolous insects such as the gerrids are extremely favourable for the study of relative growth since in these insects' comparable stages (instars) are well marked and the structures do not undergo drastic modifications until the adult stage is reached.

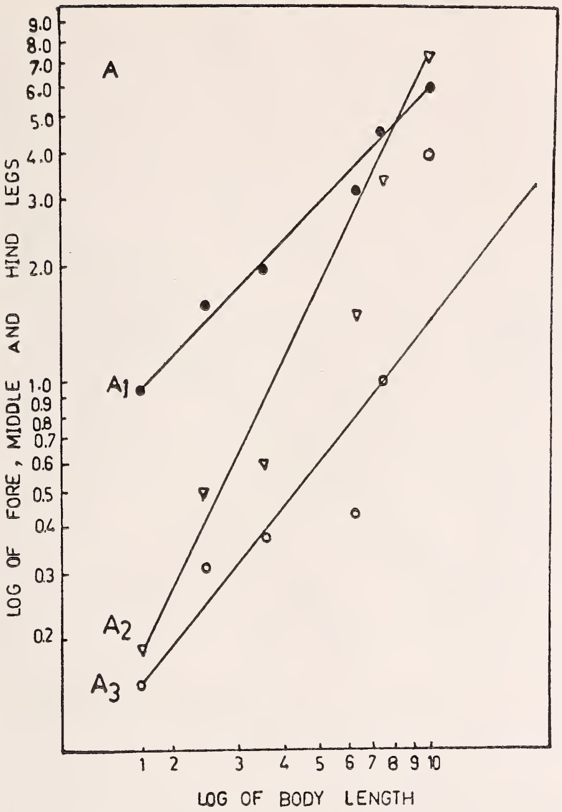
The value of antennal segments and leg segments of the above two species are plotted against the total body length at different stages of development (Figs. 1, 2).

In *Limnogonus fossarum fossarum*, the first antennal segment shows a higher growth unlike the second segment which shows just a straight line; in the foreleg segments, the femur and tibia show nearly similar growth ratio. The tarsal segments reveal simple straight allometric growth. A similar type of growth pattern has been noticed in the case of middle leg segments. In the hind leg segments, all the three segments show a higher ratio. When the total length of the legs is plotted logarithmically against body length, a simple allometric growth pattern is found as a nearly straight line, except in the middle legs where the adult shows a high growth ratio. In general, the nymphal head width, head length, rostrum and antennae show a simple growth pattern, except the fifth instar where the antenna shows a higher growth ratio. Further, for head width, the adult shows a lesser growth ratio while the head length reveals a higher growth.

In *Limnogonus nitidus*, the regression curve for the first antennal segment shows a straight line while the second, third and fourth segments show more or less a straight line up to the fifth instar nymph and adult stage. In the foreleg segments, the femur and the tarsus show more or less straight line, while the tibia shows less growth in the first, second and third instars; the later stages show straight lines. In the middle leg, the femur, the tibia and the tarsus show similar growth patterns except the fifth and adult stage femora where it shows less growth. In the hind leg of the fourth instar, the femur shows less growth, while the tibia reveals maximum growth. The tarsus shows very slow growth right from the first instar to the fifth instar, while the adult shows maximum growth.

DISCUSSION

The habitat preferences of gerrids, like most other aquatic Hemiptera, are rather divergent,



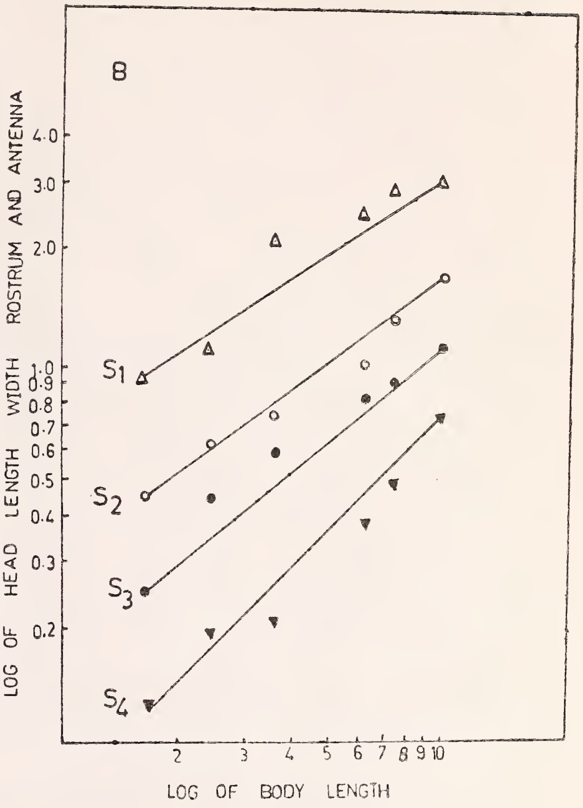


Fig. 1A. Fore leg, middle leg and hind leg measurements of post-embryonic stages of *Limnogonus fossarum fossarum* plotted logarithmically against total body length. A1. Foreleg; A2. Middle leg; A3. Hind leg.

Fig. 1B. Rostrum, head width, head length and antennal measurements of post-embryonic stages of *Limnogonus fossarum fossarum* plotted logarithmically against total body length.
S1. Rostrum; S2. Head width; S3. Head length; S4. Antenna.

and it is also known that widespread species like *Limnogonus fossarum fossarum* and *Limnogonus nitidus* are ecologically ubiquitous, colonizing a great variety of habitat such as lakes, water reservoirs, paddy fields, slow-flowing streams and even sulphur pools. Lundblad (1933) has drawn attention to this aspect of habitat diversity in closely related species of gerrids. In the present study, *Limnogonus fossarum fossarum* is not only found in permanent water bodies such as Chetpet pond, but it is also found to colonize temporary water bodies like rainwater puddles, shallow ponds and water stagnations in fields.

The adaptations exhibited by the gerrid species increase their survival value; for example, *L. fossarum fossarum,* at the slightest disturbance, escapes by taking refuge among emergent vegetation of the pond, camouflaging itself very effectively. A relation between the

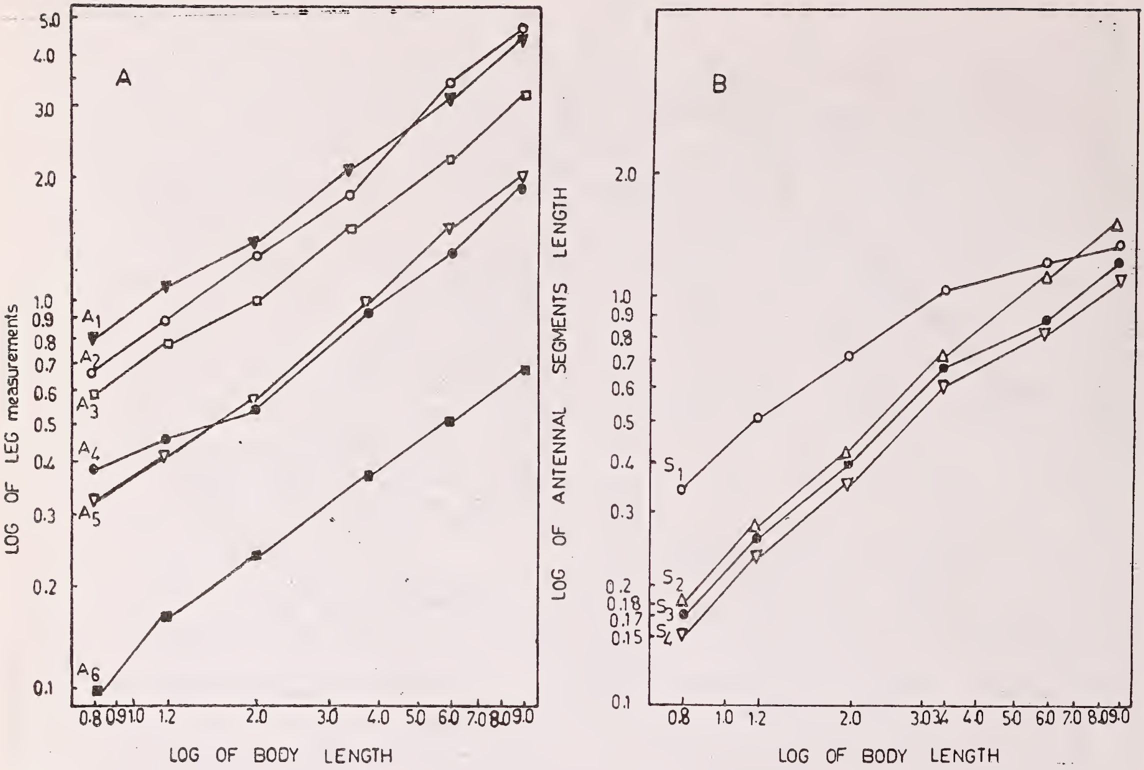


Fig. 2A. Fore leg and middle leg measurements of post-embryonic stages of *Limnogonus nitidus,* plotted logarithmically against total length.
A1. Middle leg Tibia; A2. Middle leg Femur; A3. Middle leg Tarsus; A4. Foreleg Tibia; A5. Foreleg Femur; A6. Foreleg Tarsus.

Fig. 2B. Antennal measurements of post-embryonic stages of *Limnogonus nitidus* plotted logarithmically against total body length.
S1. Segment I; S2. Segment II; S3. Segment III; S4 Segment IV.

vegetation of the pond and the aquatic hemipterans was mentioned by Tonapi (1959) who correlated the occurrence of Gerridae with *Lemna.* In the present study, gerrids are found to occur in different habitats in some of which *Lemna* was found to be totally absent. The absence of this plant in no way appears to affect the inhabiting gerrids, particularly in the matter of oviposition, since these insects could lay their eggs on floating objects or on the material just beneath the surface water or rocks found on the margins of streams or ponds. This conclusion is in conformity with that drawn by Drake (1915), Rao (1969) and Matthey (1975).

Among the physical factors, temperature appears to exert a significant influence on the incubation period. According to Hoffman (1936), the eggs of *L. fossarum fossarum* hatched in six days when the temperature ranged between 20° and 23°C., while Andersen (1975) has reported the same duration of embryonic period at 20°C. Jordan (1952) states that the egg stages of gerrids lasts

6-20 days depending upon the temperature. In the present studies, it has been found that in both the species the minimum incubation period of six days occurs when the temperature averages 32°C., while at 28°-29.4°C the incubation period is prolonged to 8-10 days. Laboratory experiments conform the field observations, but no hatching takes place when the temperature is lowered below 22°C. From this, it is evident that the gerrid eggs, like those of other aquatic hemipterans, require an optimum range of temperature for normal hatching; a rise in temperature, within limits, tends to accelerate the incubation period.

Gerrids, in general, never exhibit much food preference, and according to Andersen (1975), *L. fossarum* feeds on various animals, though insects form its chief diet, and it often attacks the terrestrial insects caught at the surface film. In the present study, it has been observed that although in the field *Limnogonus fossarum fossarum* and *Limnogonus nitidus* feed on dead or dying animals such as *Notonecta,* dragonfly nymphs etc., they show a preference to the nymphs of *Notonecta* in the laboratory. Refusal of food and sluggishness just prior to moulting were also noticed, similar to the observations of Hoffmann (1936) in *L. fossarum.*

As in other Hemiptera, gerrids have got five nymphal instars, the duration of which varies in different species and also in the same species under different conditions. According to Brooks & Kelten (1967), gerrids require 5-6 weeks for their postembryonic development. Bollwog (1915) was the first to study the developmental rates of gerrids and he reported that the younger instars developed faster than the last two instars. According to Hoffmann (1936), the duration of each of the first four instars of *L. fossarum* is almost equal, the fifth and last instars lasting nearly twice as long as each of the preceding nymphal stages. In the present study, however, both the species of gerrids show more or less equal duration of each nymphal stage. Many authors, particularly. Poisson (1924), Jordan (1929), Ekblom (1941, 1950), Larsen (1950), Guthrie (1959), Brooks & Kelton (1967), Kauffmann (1971) and Vepsalainen (1971, 1973) have emphasized the fact that increase of temperature reduces the nymphal duration and vice versa. The impact of temperature is evident in the two gerrid species here as well.

Present studies on the postembryonic growth in the two species of gerrids reveal that the different structures exhibit a more or less simple allometry. In *Limnogonus fossarum fossarum,* the antennal segments I and II reveal a higher growth ratio while the segment IV records the lowest. This situation agrees with the earliest work of Hoffmann (1936) on *L. fossarum.* The femur and tibia also show a nearly parallel allometric slope line of growth pattern. The same observation was made by Hungerford & Matsuda (1960) in *Limnoporus limnoporellus* complex. *L. nitidus* also shows the same type of growth pattern as observed in *Limnogonus fossarum* by Hoffmann (1936).

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PHAYRE'S LEAF MONKEY (*TRACHYPITHECUS PHAYREI*) IN CACHAR[1]

ANWARUDDIN CHOUDHURY[2]

(*With three text-figures*)

This paper deals with the discovery, distribution, habitat and status of Phayre's leaf monkey in Assam, a monkey that was hitherto unknown in Assam.

INTRODUCTION

Phayre's leaf monkey (*Trachypithecus phayrei* Blyth, 1847) is a little known langur distributed in the forested areas of Burma and Thailand. Its westernmost distribution range also covers Chittagong Hill Tracts of Bangladesh as well as hill forests of Sylhet district. It is a dark ashy bluish-brown langur of about 135-137 cm length, including about 75 cm tail. Head and tail-ends are darker. The underparts are whitish. Its lips and areas around the eyes are white.

Very little is known about the ecology and behaviour of this leaf monkey. Some work was done by Blanford (1888-91) in Burma, Fooden (1971) in Thailand, Green (1978) in Bangladesh and Mukherjee (1982) in Tripura. It is easily recognised in the field because of its colour, and also its eyes and lips.

PHAYRE'S LEAF MONKEY IN INDIA

In India Phayre's leaf monkey is perhaps one of the least known primates. Roonwal and Mohnot (1977) in their book "Primates of South Asia" did not even mention its existence anywhere in India. Agarwal (1974), Agarwal and Bhattacharya (1977) did some studies on its taxonomy and distribution. Green (1978) in his report on Bangladesh primates mentioned its occurrence in areas which are adjacent to Tripura. Until its sighting in Cachar its known distribution in India was limited to Tripura.

R. P. Mukherjee, of the Zoological Survey of India, visited Tripura in 1976 and in 1978 and has done some study in its natural habitat. His survey revealed that this little known colobid monkey has a wide distribution in Tripura. It is recorded from all the three districts of Tripura.

Its occurrence in Assam was first reported by me in two articles published in Tigerpaper (1983) and World Wildlife Fund-India Newsletter (1983) as well as in some notes in the local English dailies like 'The Sentinel' and 'The Assam Tribune'. My reports were based mainly on assumptions and I mentioned the Longai reserve forest of present Karimganj district as the probable habitat of the monkey. The Longai forest is contiguous with the forests of Tripura. Later Gittins & Akonda (1982) reported its occurrence in the Patharia hill forests of Sylhet (Bangladesh), which also brightened the prospects of its occurrence in Karimganj, as more than half of the Patharia hill forest is inside Karimganj. It appears that the leaf monkey may also exist in Mizoram.

DISCOVERY IN CACHAR

I was on a field trip to the evergreen rainforests of the southern regions of Assam's

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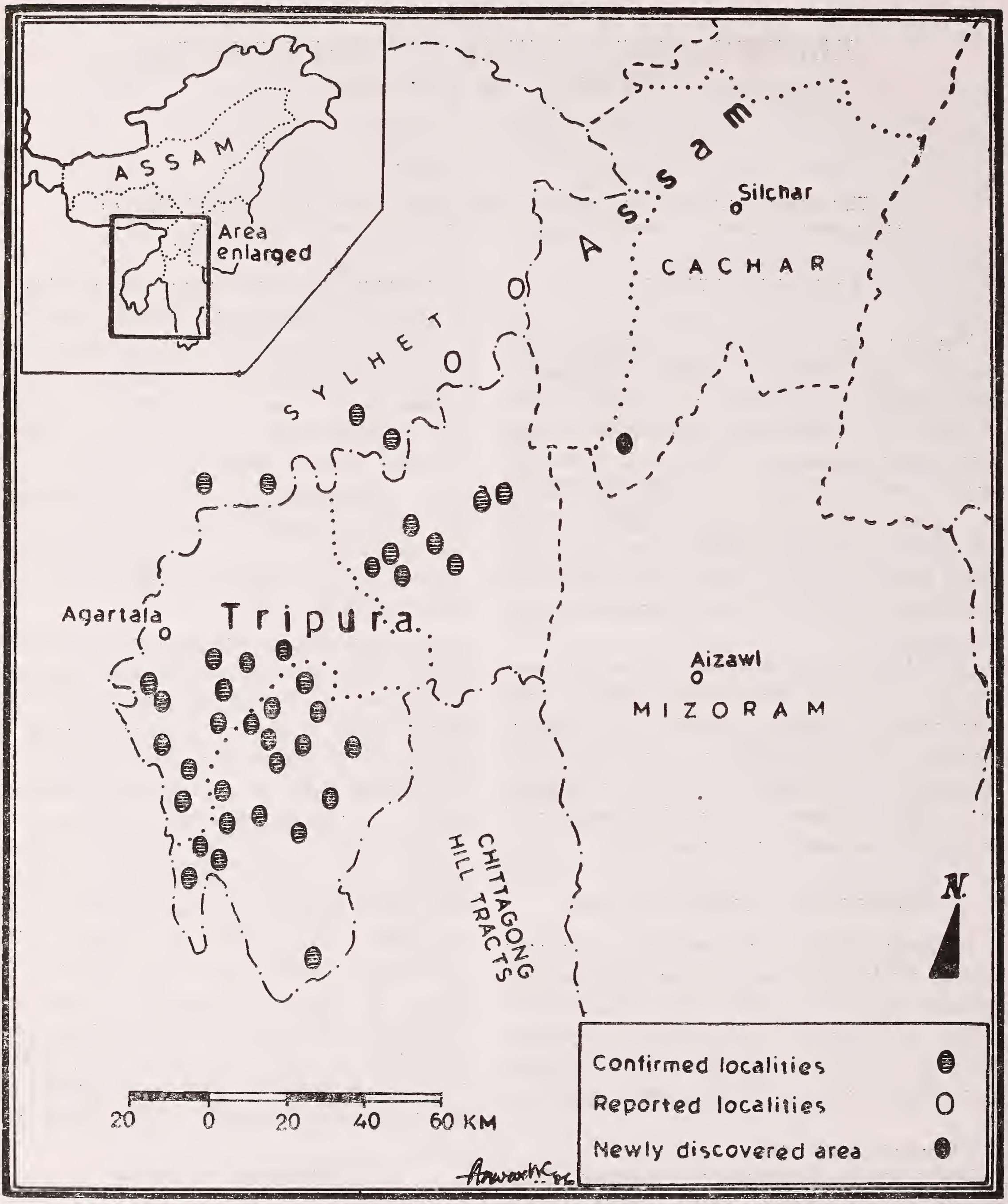
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Area enlarged
Assam
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Tripura
Agartala
Aizawl
MIZORAM
CHITTAGONG HILL TRACTS
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20 0 20 40 60 KM
Confirmed localities
Reported localities
Newly discovered area

Fig. 1. Distribution of Phayre's leaf monkey in India and Bangladesh.

Cachar district. The purpose of the trip was to study the distribution, habitat and status of non-human primates. But I never thought that the Phayre's leaf monkey might also exist in the area.

It was on 21 March, 1986 that I went to a place called Nagorhgena inside Innerline reserve forest in search of hoolock gibbons (*Hylobates hoolock*). Nagorhgena is actually a streamlet discharging its water to Damchara, a tributary of Dhaleswari river.

While following the call of the hoolock with two local guides, a blackish moving object diverted my attention to a bamboo jungle. But it was near the base of the hills and the call of the hoolock was still about a ¼ km away. As it was not jet black, I knew that it was not a hoolock gibbon. Within a moment it became fully visible, and it took only a moment for me to recognize it as a Phayre's leaf monkey. It sat on a leafless partly-cut tree. The time was around 8.45 a.m.

It did not pay heed to our presence. But when I approached closer, it fled towards the bamboo jungle. Later we moved further north for a few hundred metres when a troop of about eight individuals was seen on the ground When I approached closer, they slowly (one by one) retreated to the bamboo jungle. When I left the area and went out of their sight, a loud groaning sound came out from the bamboo jungle.

We then went towards south (south of the first animal sighted) for about ½ km. Two Phayre's leaf monkeys were seen feeding at about 8-10 metres above the ground. Three more were seen inside dense vegetation. The leaf monkey that I saw appeared to be much tolerant of human presence as the distance between me and the last mentioned troop was only about 15 metres and at no time were they panicky.

Then on 22 March I again visited Nagorhgena, this time in the evening. No monkey could be seen in the previously sighted locations. Two individuals were seen on the hill-top area. Later, a little distance away a small troop was seen again on the hill-top area.

My last visit to the leaf monkey habitat was on 25 March. For the whole day I stationed myself at the base of the hills on the trans-Nagorhgena side (eastern edge), i.e. facing Dhaleswari river. In the morning I moved around the base, especially the localities where we had already sighted them on previous occasions. But no trace could be found. I also trekked areas near Damchara stream but in vain.

There was mild rainfall in midday. Just after the rains, about nine Phayre's leaf monkeys, including three juveniles, appeared in the area. The troop was spread over a wide area and was seen busy feeding. Two individuals were also observed resting on tree branches near the hill-top area.

HABITAT, STATUS AND ASSOCIATION WITH OTHER ANIMALS

The area where Phayre's leaf monkey has been sighted (i.e. Nagorhgena) is about 3 km south-west of Gharmura. Gharmura is 56 km south of Hailakandi, the nearest Sub-divisional headquarter. The geographic location of the area is 24° 17′ N and 92° 30′ E. The area is actually a low hill range, running in a north-south direction. The low hills are the northern promontories of Mizo (Lushai) hills. To the east is the wide bank of Dhaleswari river, while to the west is the small plain (locally called 'thal') formed by Nagorhgena streamlet. While the hill is covered by depleted evergreen forest with extensive bamboo jungles, the Nagorhgena *thal* as well as the level Dhaleswari bank is under human habitation. A few tall trees were there mainly in the hill-top area which included some deciduous trees like Shirish (*Albizzia stipulata*). Bamboos covered the hillslope area with Muli (*Melocanna bambusoides*) as the main species.

At the base of the hills on the Nagorhgena side, patches of wet grasslands (locally called 'terabon') were present. The first troop of eight was seen on such a grassland. But exactly where the monkeys sat could not be ascertained as there were some fallen bamboos on the ground. The habitat is very much disturbed as settlers from both sides enter the forest daily for collection of firewood and bamboos.

The climate of the area is tropical. Summer is hot and wet, while winter is generally cool and dry. The annual precipitation is between 2,400-2,800 mm, much more than the leaf monkey habitat of Tripura where it is about 1582 mm (Mukherjee 1982). The bulk of the rain falls during summer, but winter rains are also common.

The status of Phayre's leaf monkey in the rest of Cachar as well as Karimganj district is not known. After the sightings in Nagorhgena, I tried to survey the eastern bank of Dhaleswari river to confirm whether Dhaleswari river is the eastern distributional limit of the species, but due to lack of time and resources I could not carry out a detailed study. But there are unconfirmed reports of sighting received from as far northeast as Bilaipur. It is very likely to exist towards west upto Tripura border.

The most interesting fact about Phayre's leaf monkey is that till 21 March (1986) it was not properly recognised by the locals as well as forest officials, who confused it either as a 'tailed' hoolock gibbon (due to blackish colour) or as 'black' capped langur (due to its long tail), and that is why it has no local names in the area. It was only after my clarification that it is a different monkey, that some persons started calling it as 'lamba leinge-ala kala bandor' i.e. longtailed black monkey.

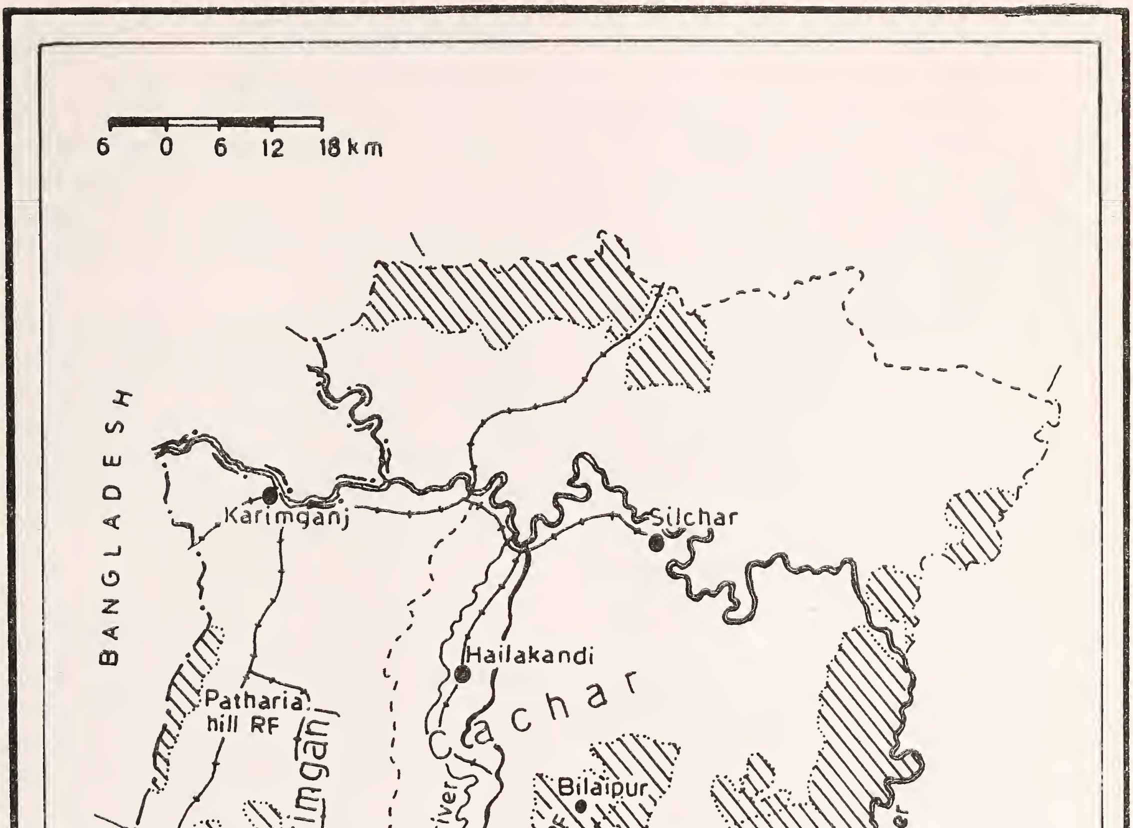
Other primates observed in the Nagorhgena hillock were Rhesus macaques (*Macaca mulatta*), Hoolock gibbons (*Hylobates hoolock*) and Capped langurs (*Presbytis pileatus*). But contact between Phayre's leaf monkey with other primates was not observed. However, the troop that was sighted on 25 March afternoon was almost at the same spot where hoolock gibbons were sighted in the morning. Other significant tree-loving mammals in the area are the Malayan giant squirrel (*Ratufa* sp.). Sambar (*Cervus unicolor*), muntjak (*Muntiacus muntjac*) and wild pig (*Sus scrofa*) are the main ground mammals of the area.

PHAYRE'S AND BARBE'S LEAF MONKEYS

Are Phayre's and Barbe's leaf monkeys, the same, and what are the basic taxonomic differences between the two? Are both the species found in India? These are some of the questions open for discussion.

R. P. Mukherjee (*pers. comm.*) informed me that the distribution and taxonomic position of Barbe's leaf monkey (*Presbytis barbei* Blyth) is not known with certainty. Finn (1929) mentioned Tipperah (Tripura), upper Burma, Kakhyen hills and Tenasserim as the distribution range of Barbe's leaf monkey. According to him, Phayre's leaf monkey was not found in India, and is distributed in Arakan, Bassein and north Tenasserim.

Interestingly, Vol. 79 (1) of the *Journal of the Bombay Natural History Society* published two papers, one on Phayre's leaf monkey of Tripura (R. P. Mukherjee) and the other on Barbe's leaf monkey, also of Tripura (S. K. Mukherjee). The characteristics, including body colour, colour around eyes and lips appeared to be the same in both the papers. The distribution (in Tripura), habitat as well as food also seems to be similar. While R.P.M. did not mention anything about Barbe's


6 0 6 12 18 km
BANGLADESH
Karimganj
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Hailakandi
Cachar
Patharia hill RF
Karimganj
Bilaipur
Katakhal RF
Dhaleswari river
Barak river
Innerline RF
TRIPURA
Longai RF
Gharmura
Nagorngena
MIZORAM
N
Reserved forest ▨

Fig. 2. Cachar and Karimganj districts with reserved forests.

monkey in his list of primates, S.K.M. also did not name phayre's monkey in his list of Tripura monkeys. How did Barbe's monkey evade R.P.M.'s notice and Phayre's monkey S.K.M's notice, when both the species seem to be well distributed throughout Tripura and are not uncommon? At least they would have mentioned the existence of the two species in Tripura. It might well be that the two species, both of which are called Dudhi-Mukho bandor or Chosma Chok in Tripura, have been confused in the field. Dense vegetation may also be a reason for that. R.P.M. might have taken all the 'spectacled' and white lipped monkeys as Phayre's species, while S.K.M. as Barbe's. S.K.M.'s description of coloration of Barbe's monkey does not tally with Finn (1929) who described it as 'black with dark-blue face, lips often light'. This, therefore, needs confirmation.

The book on primates by Napier and Napier (1967) did not recognise the existence of any monkeys like Barbe's leaf monkey, so also Roonwal and Mohnot (1977).

DISCUSSION

Not only is the small leaf monkey habitat (so far known) a very disturbed one (reasons already mentioned), various other factors have threatened its very existence. Burning of forests by Reang tribesmen and forest personnel, and the expansion of encroachment pose an immediate threat to this small hillock. While the Reang tribesmen clear forest for jhum (shifting) cultivation, the Forest Department's main intention is plantation.

A very big area covering several hundred hectares adjacent to the leaf monkey habitat have been burnt down completely during my camping period at Gharmura (exact measurement of the area could not be taken). Such burnings are generally resisted by the encroachers as they collect firewood, building materials etc. from forests; moreover they cultivate permanently on flat valleys. Uncontrolled burning sometimes causes extensive damage to life and property of the encroachers. The encroachers along both sides of Nagorhgena hillock are also determined to save the hillock from burning.

Some of the encroachers expressed their willingness to surrender their land to the 'leaf monkey's provided some sort of employment is given to them. Who else can be a good game watcher than these encroachers who know every bit of the forest? Moreover it is unlikely that most of the encroachers could be evicted, as it often becomes a political issue.

So, considering the biological importance of the area, some steps must be taken. If the clash between encroachers on the one hand and Reangs and Forest Department on the other hand ends in favour of the latter, then the hillock may face complete destruction next winter.

Thus, in order to save the only known troop of Phayre's leaf monkey, Government should do something positive (like declaring the area as a sanctuary) and that too without delay. The confidence of the people who are sharing the habitat with leaf monkeys for the past few years must be gained, otherwise the very concept of conservation will not succeed.

It may also be mentioned here that the Government of Assam has already been moved in (1983) to declare the whole forest belt of southern Cachar-Karimganj as a wildlife sanctuary, but hardly anything practical has been done till now.

Moreover, the local people have nothing against the leaf monkey, as it never invades cultivations.

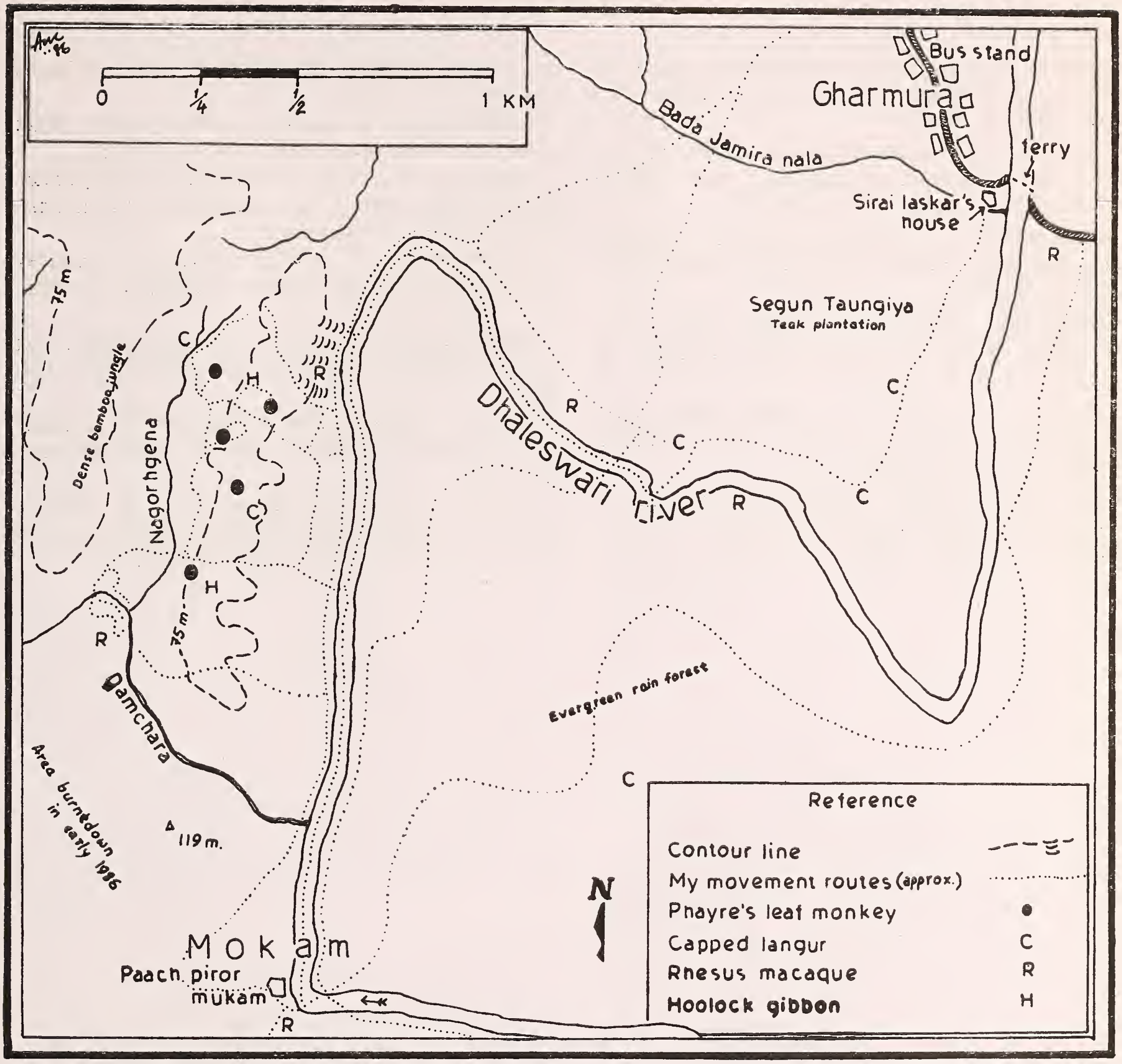
0
¼
½
1 KM
Bus stand
Gharmura
Bada Jamira nala
ferry
Sirai laskar's house
R
Segun Taungiya
Teak plantation
75 m
Dense bamboo jungle
Nagorhgena
C
H
R
Dhaleswari river
C
Evergreen rain forest
Damchara
75 m
Area burntdown in early 1986
119 m.
Mokam
Paach piror mukam
N
Reference
Contour line
My movement routes (approx.)
Phayre's leaf monkey ●
Capped langur C
Rhesus macaque R
Hoolock gibbon H

Fig. 3. Phayre's leaf monkey area in Cachar with sighting locations. Sighting locations of other primates is also shown.

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Mr. Fulmon Kurmi, my local guide and Mr. Amir who actually guided me in the leaf monkey habitat, deserve special mention. Thanks are also due to Dr. M. Taher, Head, Department of Geography, and Dr. P. C. Bhattacharjee of the Zoology Department (both of Gauhati University) for their advice in various matters.

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BREEDING BIOLOGY OF BARBETS, *MEGALAIMA* SPP. (CAPITONIDAE: PICIFORMES) AT PERIYAR TIGER RESERVE, KERALA[1]

H. S. A. YAHYA[2]

(*With six text-figures and a map*)

INTRODUCTION

The genus *Megalaima*, which includes all the nine species of Indian Barbets, is a prominent group of hole nesting birds well represented throughout the Indian sub-continent. Friedman (1935), Chapin (1939), Moreau & Moreau (1940), Skutch (1944), Skead (1950) and Short & Horne (1979, 1980) have studied the life histories of some of the African and American barbets, but a similar study of an Asiatic barbet is not available. This paper is based on the work done between 1977 and 1980, mainly at Periyar Tiger Reserve, Kerala (Map 1).

Nests of hole-nesting birds are difficult to observe in comparison to other groups of birds. In the present study, a successful method was devised, allowing regular examination of nest contents.

METHODS

Only breeding pairs of *M. viridis* and *M. rubricapilla malabarica*, found excavating holes for a minimum of five consecutive days, were selected for regular observation, and nests were then marked serially. 96 nests of *viridis* and 36 nesting attempts of *rubricapilla* were monitored during three breeding seasons (1978-1980). Among these, 18 nests of *viridis* and 8 nests of *rubricapilla* were cut open to determine the clutch size, incubation and nestling periods, growth rate of the nestlings and fledging success.

Six nests of *viridis* and 4 nests of *rubricapilla* were intensively studied to determine the percentage of attentiveness by the parents during incubation and percentage of food materials fed to the nestlings during different hours and days of nesting periods. Observations were made for at least one shift of four hours each, from egg laying till the nestlings fledged, for each of these nests. In most cases it was not possible to identify individual insects, so food items were recorded only as 'plant material', 'animal material' and 'undetermined'.

Weights of nestlings from six nests of *viridis* and three nests of *rubricapilla* were taken to determine weight and other changes in relation to their age. Weight was taken on every third day at 0900 hrs. The nestlings were not weighed after the 30th day, because no significant change in their weights was evident after the 27th day. After this, there was also a considerable risk of premature fledging following disturbance.

Calculation of time spent on nest incubation:
Suppose, total hours in one complex day
(24 hrs) ± T
roosting hours (incubation during nights) = R
then the total day hours = T–R = D

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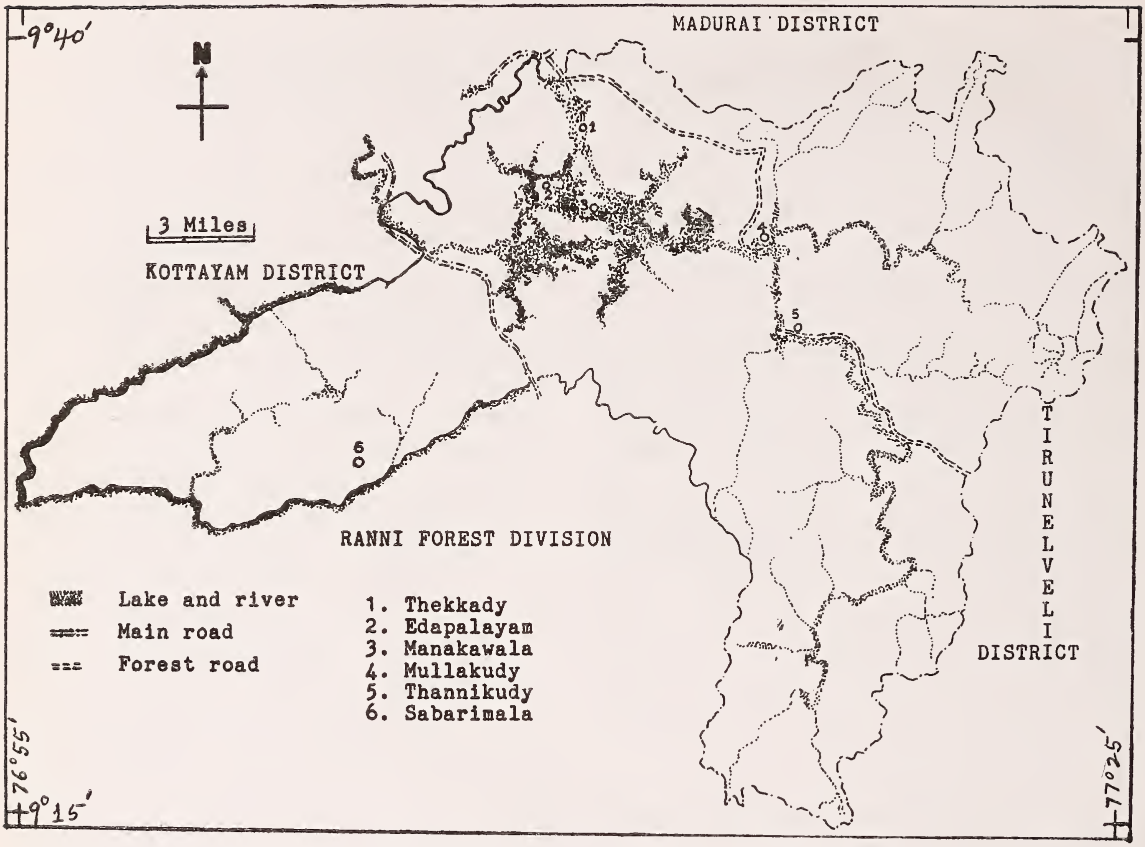
9°40′
N
MADURAI DISTRICT
3 Miles
KOTTAYAM DISTRICT
1
2
3
4
5
6
RANNI FOREST DIVISION
TIRUNELVELI DISTRICT
Lake and river
Main road
Forest road
1. Thekkady
2. Edapalayam
3. Manakawala
4. Mullakudy
5. Thannikudy
6. Sabarimala
76°55′
9°15′
77°25′

Map. 1. Periyar Tiger Reserve, Kerala.

In *P hrs* (4 hr-shift) observation the bird was found incubating for *N hrs*
then in D hrs, incubation would be for $N/P \times D = Y$
Thus, the total incubation in T hrs = Y+R
Therefore, the % of attentiveness of incubation

$$= \frac{(Y+R) \times 100}{T}$$

Note:

(1) Times of settling and emerging of parents were noted on every fifth day to determine the roosting/incubation hrs. during nights.

(2) In the final calculation, equal number of each shift (i.e. morning, noon and afternoon) were recorded to avoid error.

Gaining access to nest contents:

Easily accessible and preferably freshly excavated nests were selected. As soon as the birds completed excavation, a small block of wood was neatly cut out with a hacksaw thus making an opening horizontally and diagonally at the opposite side of the entrance about 8 cm above the nest chamber. This opening was to provide enough space for handling nest contents. A nail was then fixed (Fig. 1) to the middle of the block, and after observation the wedge was replaced and tied tightly with a string.

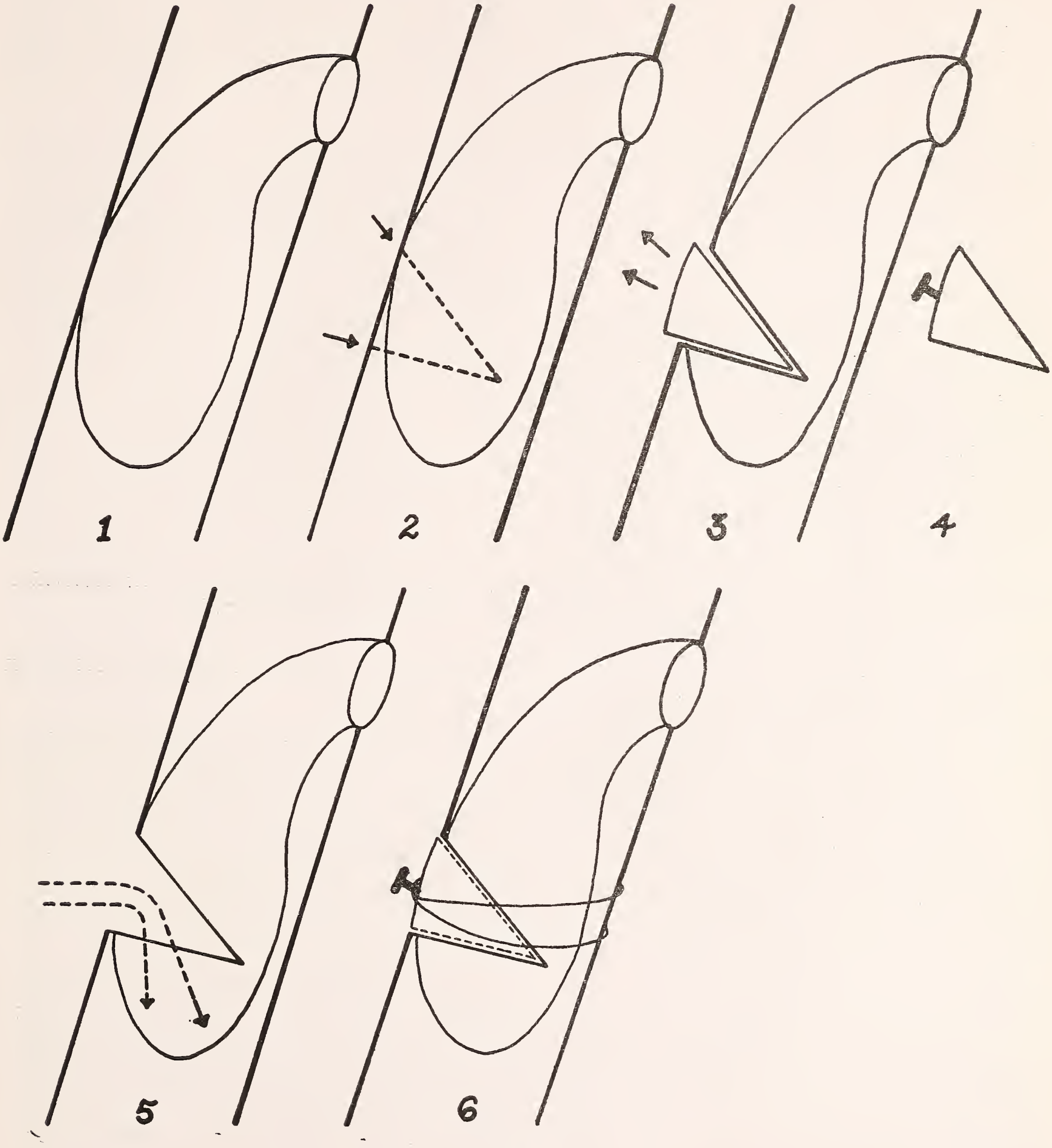

Fig. 1.

1. Section through nest-hole; 2. Direction of cuts with hacksaw indicated by arrows and dotted lines; 3. Cut wedge of tree removed; 4. Cut wedge with thin nail driven into it; 5. Nest conveniently open for examination of contents; 6. Wedge refixed and held in place by string which loops over nail in wedge.

In the second phase of the study in 1979, four pairs of *viridis* were colour banded to determine the nature of pair formation. In the last phase of the study, three banded *viridis* and one *rubricapilla* were collected and dissected to ascertain the sex of birds incubating/brooding at night. Two 'Machan-hides', one for each species, were installed for closer observation and photography at a distance of two metres from the nests.

The Breeding Cycle:

BREEDING SEASON:

Barbets have an extended breeding season. This is partly due to hole excavation habit and partly to the nidicolous nature of the nestlings. A 'minimum' of *c.* 65 days is required to raise a successful brood. At Periyar Tiger Reserve, *viridis* start nesting activity from December and finish in July. In comparison, *rubricapilla* has a shorter breeding season, starting in December and ending in May. In both cases, these periods are longer than those currently acknowledged in the literature (Baker 1934, Ali & Ripley 1970).

I recorded the majority of breeding pairs of both species from January to May (Fig. 2). Feeding the nestlings was observed in *viridis* as late as July, whereas no nest of *rubricapilla* was found after May. Between January and May rainfall is comparatively less and it appears that at Thekkady, barbets and almost all other birds complete nesting activities before it started raining heavily in July.

Courtship and pair formation:

M. viridis seems to pair for more than one breeding season (Thomson 1964). This was ascertained in the third phase of the study when three out of the four pairs were found pairing and breeding again. I found the male of the fourth pair nesting with a different female and presume that his previous mate had died, as I undertook extensive search in the surroundings.

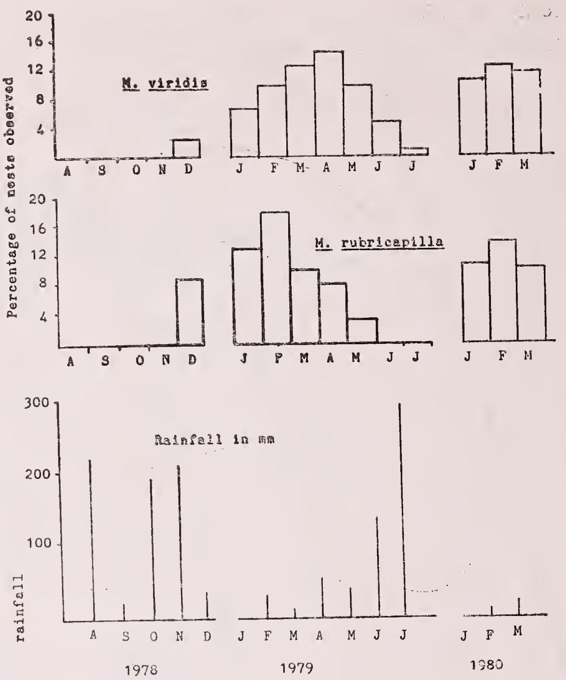

Fig. 2. Rainfall and percentage of nests observed in different months.

Vocalisations forms the major mode of courtship and display among barbets. In both the species, calls are used in both the pre- and postnuptial displays. As soon as the drier months commence, barbets become more vocal and call loudly and shrilly throughout the day till the eggs hatch. After the eggs hatch, pairs become markedly less vocal. However, pre- and post-roosting calls and territorial or alarm calls are still noted at this time as usual (Yahya 1980, 1984). During nest excavation and copulation, courtship feeding is regularly seen in both the species. However, during my intensive study of six pairs of *viridis*, I never found them feeding their mates during incubation; while excavating the nests the relieving partners of several pairs of *viridis*, *rubricapilla* and *M. haemacephala* (at Borivli National Park and Lower camp) were observed feeding the excavating mates. Van Tyne & Berger (1971) state that courtship feeding occurs primarily in genera in which the sexes remain together throughout the breeding season.

Copulation:

Altogether, pairs of *viridis* and *rubricapilla* were observed copulating on 11 and six occasions respectively. In both the species, copulation is normally completed in two successive mounts, each lasting for 6-7 seconds. During copulation the female crouches, her tarsal joint at about 30° to the perch and gives *cheen, cheen* .... 'soliciting calls'; the wings of both birds flutter and tails are fanned. The cloaca are pressed together, the male being at an angle of about 60° to the female. On seven occasions, males of *viridis* were observed feeding their mates; on five occasions just before, and twice just after, copulation. MacDonald (1961) and Ravi (1966) have also recorded male *haemacephala* feeding the female after copulation.

Two pairs of *viridis* and one pair of *rubricapilla* which raised a second brood were observed copulating 5 to 7 days prior to the fledging of the first brood.

On three occasions I recorded the males of *viridis* mounting the female without pre- or postnuptial courtship feeding; no successive mount was recorded on those occasions.

Nest site selection and excavation:

Almost all the nests observed at Thekkady and elsewhere were found in the dead branches of trees. Owing to their larger beak, *viridis* excavate in thicker branches or often in a dead part of the trunk, whereas all the nests of *rubricapilla* were recorded in thinner branches. Because thinner branches are fragile, these nests are often destroyed by heavy rain/wind: *rubricapilla* pairs have to excavate a new nest almost every year. According to Short (1979), newly excavated holes lack pests such as ticks, so this necessity to excavate new holes may carry hidden benefits. However, sometimes suitable roosting holes are also renovated for nesting. But if enough space is available, both species prefer to excavate a new hole in the same branch and at times several holes are found in a single branch. The surplus holes are used for roosting by the pair and their young (Yahya 1980).

Colonial nesting and nesting locality:

I could not determine any well defined territories for pairs of *viridis* or *rubricapilla*; the birds simply defend the nesting branch from intruders. However, *viridis* is more tolerant of its own kind, and several pairs may nest fairly close to each other, the minimum distance recorded between two active nests being 19 m. Nests of *rubricapilla* are always found scattered, and only on one occasion were two pairs recorded nesting as close as 70 m from each other. Therefore, 'loose colonial nesting' (Lack 1968) appears to be pronounced among *viridis.*

Although nests of *viridis* were recorded fairly close to each other, I never found the two species nesting together in a single tree. On two occasions, pairs of *rubricapilla* were driven away by the pairs of *viridis* when the latter selected the same tree for nesting. However, Vergese & Govindakrishnan (1975) have observed a pair of *viridis* and pair of *haemacephala* nesting in opposite branches of a Bead tree (*Melia azedarach*) at Bangalore. Friedman (1935), quoted by Skutch (1944), stated that a dozen or even two dozen pairs of *Gymnobucca* (African barbets) may have their nest-holes in the same tree, while neighbouring trees are wholly devoid of holes.

Nest defending behaviour:

Interspecific aggression is pronounced among *viridis*; they constantly harass any pair of *rubricapilla* nesting in their vicinity, at times even destroying their nests. Besides driving away their own kind from nesting trees, pairs of *viridis* were observed defending their nests from other tree hole-nesters like woodpeckers, mynas and tits. However, on several occasions I found *viridis* excavating or incubating, unperturbed by the presence of a non hole-nester. It appears that, like woodpeckers (Short 1979), barbets 'recognise' potential nest-competitors and act appropriately towards them. However, I did not observe any interaction between *viridis* and other hole-nesters at sites other than nesting sites, as has been recorded by Short between the Black-backed woodpecker and Tree Swallows.

The other animal from which the barbets defend their nests is the Three-striped Palm Squirrel, which is reported to be a persistent egg robber (Prater 1971). Almost all the pairs of *viridis*, *rubricapilla* and a pair of *M. zeylanica* (observed at Hazaribagh) were seen chasing squirrels away from the vicinity of their nests.

While *rubricapilla* defends its nests against other hole-nesters and squirrels, this species is mostly harassed by the former species. Whenever a *viridis* located the nest of a *rubricapilla*, it tried to destroy the nest, either by pecking at the entrance or by preventing the parents from feeding the nestlings. Among six unsuccessful nests of *rubricapilla*, three were destroyed by three different pairs of *viridis*; the first nest contained two nestlings, the second two eggs and the third pair was dispossessed of the nesting branch during excavation.

In all the encounters observed the larger *viridis* individuals were successful in dispossessing a *rubricapilla* of their nests. I never documented the opposite outcome, as has been reported by Short (1979) in case of the Crested Barbet (*Trachyphonus vaillantii*).

Nest height:

As shown in Fig. 3, *viridis* and *rubricapilla* nest at different heights from the ground. The preference of certain nesting heights in these two species corresponds to their different feeding zones (Yahya 1980).

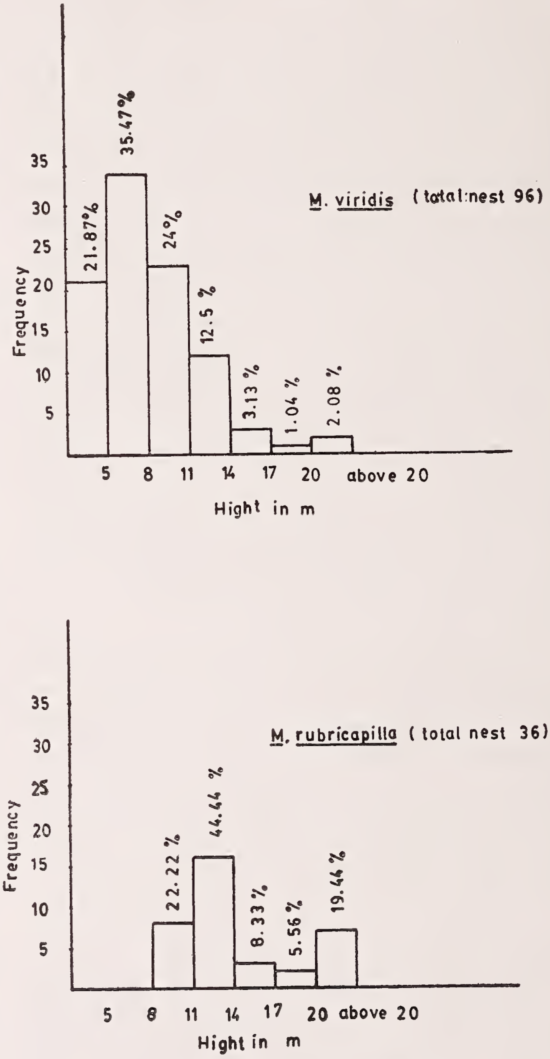

Fig. 3. Nest height preference.

Nest excavation:

In the course of selecting a new nest-site, barbets would move from branch to branch very actively, pecking at different places and sitting on a perch for a few minutes to call; they would be promptly answered by their partners. Sometimes both the partners would visit and examine the same branch again and again, at times calling and preening alternately before finally selecting the nest site. While *viridis* selects any type of branch, *rubricapilla* always prefers more or less horizontal branches and excavates strictly on the underside of the branch.

Close observation of the colour banded pairs of *viridis* showed that the males were more active in nest excavation throughout. Allen (1961) also found that, among woodpeckers and certain other groups of birds, the males take the initiative in starting the nesting cavity and do most of the work of excavation. Short and Horne (1979) have observed three White-headed Barbets (*Lybius torquatus*) excavating a single hole.

In the beginning, the excavation in both the species is slow, but it gradually picks up. During the peak period, *c.* 20-25 minutes of continuous excavation is followed by a rest of 5-7 minutes. On an average, the excavation is done for 200 minutes per day. The excavated wood-chips are taken in beakfuls and thrown down from a predetermined perch about 30-35 m away from the nest. On some occasions the birds were seen dropping the chips in mid-air before reaching the normal 'chip throwing post'.

During excavation, in both the species, the partners change shifts; while one bird is working, the other approaches the nest site and clings; the former then moves away gently and the latter resumes the excavation. While one is working inside, its partner usually clings at the entrance and immediately the former flies out, the reliever settles down to the excavation. At times, a call is also used for this purpose; the relieving partner calls from an adjacent tree while the excavation is going on inside, the working bird then comes out and the former takes its place.

On an average, *viridis* takes 20 days and *rubricapilla* 18 days to complete the nest. In all dimensions the nest of the former is larger. It appears that, owing to its larger beak, *viridis* excavates almost twice the length of nest cavity in more or less the same period (Table 1).

TABLE 1

MEAN DIMENSIONS OF NESTS OF *viridis* AND *rubricapilla*

	Diameter of entrance of hole (cm)	Depth of hole (cm)	Width of Chamber (cm)	Av. time taken (days)
M. viridis (N = 18)	5.10	32.23	9.20	20
M. rubricapilla (N = 8)	3.85	16.95	7.25	18

The nest:

The nest-hole of barbets is not just a simple hole as it may appear from the exterior. The entrance is evenly circular, being just big enough to allow the passage of one bird at a time. It is so neatly and precisely drilled out that when the bird looks out from the 'doorway', no space is left around. This narrow space is of advantage as it protects the nest from predators. The entrance leads to a bend from where the main shaft begins. The distance from the entrance to the bend (ante-chamber) differs from species to species, the larger the bird the longer the ante-chamber. This part of the nest is also of great help to the bird; being slightly downward sloping, it prevents water from entering the nest. This place also provides a secure perch, and grown-up nestlings sit in this ante-chamber to receive food from the parents just prior to fledging.

From the 'bend', the cavity leads to a uniform shaft, but widens at the distal end into an almost oval nest-chamber. The size of the chamber also correlates with the size of the bird and nestlings. No nest lining is used in either species, but there are usually some wood-chips on which the eggs are bedded.

Egg laying, clutch size and incubation:

Eggs are laid 3-5 days after the completion of freshly excavated nests. In both the species, eggs are normally laid consecutively each morning till the clutch is complete.

Butler (in Baker 1934) reported that *viridis* may lay several clutches in a single breeding season. To verify this report I investigated three nests of *viridis* and one of *rubricapilla*: All eggs were removed from two nests of *viridis* when the clutch was complete; from the third nest the first egg was taken away after the second egg was laid, and the second egg was taken after the third was laid, the last egg was left intact. From the only nest of *rubricapilla* all the eggs were taken when the clutch was complete. While the first pair of *viridis* laid eggs in the same nest for the second brood after nine days, the latter two abandoned the nests. The former also abandoned the nest when I removed all the eggs for the second time. The pair of *rubricapilla* also deserted the nest after I had taken the eggs.

It is apparent from the above that both *viridis* and *rubricapilla* do not lay more than two clutches in a season, and thus it may be postulated that they are determinate layers.

Altogether 11 pairs of *viridis* and 4 pairs of *rubricapilla* were observed raising a second brood. Both the species laid a second clutch *c.* 4-6 days after the nestlings of the first brood had fledged.

Generally *viridis* lays 3 eggs and *rubricapilla* only 2. Of 18 nest sites of the former monitored, only 3 nests contained 2 eggs, whereas among 8 nests of the latter only contained one egg. I did not find any nest of *viridis* with 4 eggs or that of *rubricapilla* with 3 eggs as reported by Baker (1934). I did not find any difference in clutch size between the first and second brood of either species.

The eggs:

Eggs of both species are white and elongated having a distinctly blunt and a pointed end, the eggs of *viridis* are larger and weigh more (Table 2). Though the size of the eggs in both the species varied slightly from brood to brood and at times within a brood, I did not find any egg, in either species, as small as reported by Baker (1934).

TABLE 2

SIZE AND WEIGHT OF EGGS OF *M. viridis* AND *M. rubricapilla*

	Sample	Average size (mm)	Average weight (g)
M. viridis	21 *(30)	29.01 × 20.36 *(26.20 × 20.00)	6.58
M. rubricapilla	7 *(9)	27.60 × 18.95 *(24.70 × 17.70)	5.68

* As given by Baker (1934).

Incubation period and attentiveness:

The incubation period is considered to be from completion of the clutch to hatching of all the eggs. The average incubation period in both the species is 14 to 15 days. Two other sympatric species of barbets, *M. lineata* (Ali & Ripley 1970) and *M. haemacephala* (Verghese & Govindakrishnan 1975), also have incubation periods of this length.

Six nests of *viridis* and four of *rubricapilla* were studied to determine the percentage of attentiveness and rhythm of incubation during different days and hours of incubation. It was found that percentage of attentiveness of the parents on incubation increases steadily and reaches its maximum 2-3 days prior to hatching in both species. In both species parents were found most attentive during the morning hours, which are generally cold at Thekkady, and least attentive during afternoon. They were also found more attentive when it rained, causing a drop in ambient temperature.

Details of percentage of attentiveness have been discussed elsewhere (Yahya 1980). The overall average calculated from the above mentioned nests shows that both these sympatric species have almost similar percentage of attentiveness, i.e. about 75%.

During the daylight hours, the two members of a pair share incubation almost equally, but the females incubate/brood alone during nights in both the species. This was ascertained by banding four pairs of *viridis* and dissecting three, and doing the same for one pair of *rubricapilla.*

During incubation, there is specific shift-change routine among barbets during which there is special use of their calls (Yahya 1980).

Hatching:

Eggs of barbets hatch on a 'first-laid first-hatched' basis. This was determined by numbering the eggs serially. The percentage of hatching in both species is very high, being over 92% (Table 3). Among the 40 eggs of *viridis* and 13 of *rubricapilla* incubated till hatching only three of the former and one of the latter did not hatch. Any unhatched egg was removed by the parents. From another nest three eggs were removed, one by one and dropped at a distance of 15 m from the nest, by a male *viridis* after I took the female for sex determination. Before removing the eggs, the male called loudly and then threw away the eggs in the afternoon.

Nestling feeding:

Regular and active feeding begins only after all the eggs of the clutch are hatched. During the first 3-4 days, the parents feed the nestlings by regurgitating insects. Thereafter, *rubricapilla* sharply switches over to fruits, whilst *viridis* continues to feed the nestlings considerable quantities of insects throughout the nestling period (Figs. 4 & 5). Parents of both the species feed the nestlings by settling inside the nests except 5-7 days prior to fledging when the nestlings often receive the food at the entrance.

The visits per hour for feeding increase, in both species, with the age and number of

TABLE 3

PERCENTAGE OF SUCCESS OF HATCHING, FLEDGING AND BROOD OF *M. viridis* AND *M. rubricapilla*

Species	Total no. of nests examined	No. of eggs laid	No. of eggs left to hatch	Hatching success No.	Hatching success %	Fledging success No.	Fledging success %	Brood success %
M. viridis	18	52	40	37	92.5	28	75.7	53.84
M. rubricapilla	8	15	13	12	92.3	9	75.0	60.00

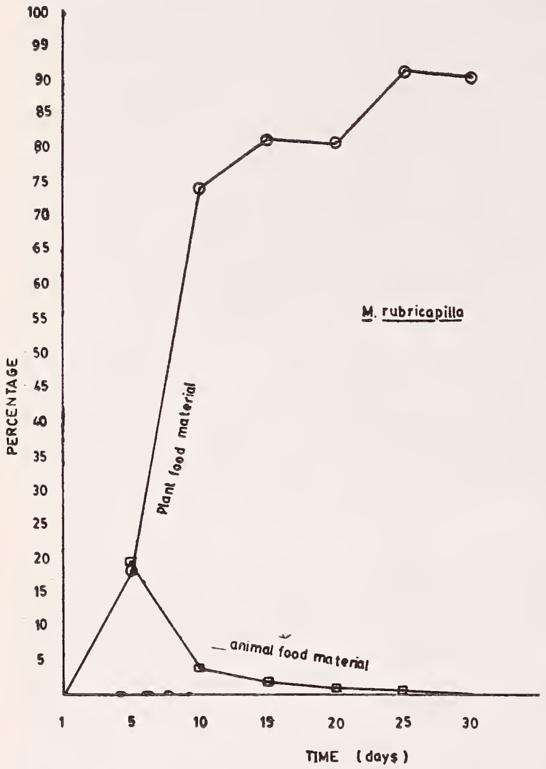

Fig 4. Percentage of food materials fed by the parents during different days of nestling periods.

nestlings. On an average, the parents of *viridis* visited the nests 9.63 times per hour when there were three nestlings, 8.46 times when there were two nestlings but only 4.7 times when there was only one nestling. All the nests of *rubricapilla* contained two nestlings and on an average, the parents visited 8.11 times per hour. (Table A-D).

In both species the rate of visits increases significantly with the increase of the age of the nestlings, till about 21 days. After this, the frequency of feeding remains more or less constant throughout the remaining nesting period.

Nest sanitation:

In both species, nest sanitation is normally performed by both sexes and the frequency of nest cleaning corresponds to the rate of feeding. In one pair of *viridis* it was only the female which performed this chore. The faecal matter is thrown about 35 m away from the nest, exactly in the same way as the barbets dispose of wood-chips during the final phase of nest excavation. Among the several nests of *viridis* cut open for observations, two contained numerous maggots but the nestlings nevertheless fledged successfully.

Brooding:

Parents of both the species were observed brooding the nestlings regularly till about the 14th day after hatching. The length of brood-

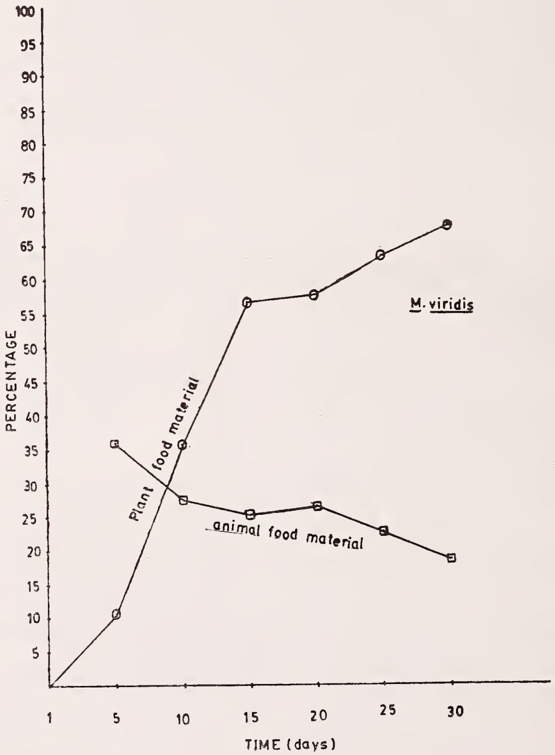

Fig. 5. Percentage of food materials fed by the parents during different days of nestling periods.

TABLE A

PERCENTAGE OF FOOD MATERIAL FED BY THE PARENTS DURING DIFFERENT NESTLING PERIODS: *M. viridis*

Nest No.	No. of nestlings	Nestling period	Days of nestling period	Percentage of food material:		
				Plant	Animal	Undetermined
V–3	2	36 days	1 to 5	5.38	26.88	67.74
			5 to 10	27.63	32.89	39.47
			10 to 15	51.09	18.42	30.48
			15 to 20	54.30	32.60	13.10
			20 to 25	53.77	31.09	15.14
			25 to last day	68.78	19.36	11.86
			Average:	43.49	26.87	29.63
V–5	1	38 days	1 to 5	12.50	37.50	50.00
			5 to 10	24.99	30.98	44.03
			10 to 15	56.76	28.14	15.10
			15 to 20	53.00	29.12	17.88
			20 to 25	69.84	17.46	12.70
			25 to last day	71.22	17.23	11.55
			Average:	48.55	26.73	25.11
V–19	2	36 days	1 to 5	17.57	35.88	46.55
			5 to 10	30.63	26.55	42.81
			10 to 15	58.30	28.60	13.10
			15 to 20	58.78	23.67	17.55
			20 to 25	57.91	28.11	13.98
			25 to last day	67.00	20.50	12.50
			Average:	48.30	27.22	24.47
V–30	3	37 days	1 to 5	7.86	30.26	61.88
			5 to 10	36.77	25.42	37.81
			10 to 15	60.11	26.34	13.55
			15 to 20	58.11	23.07	18.82
			20 to 25	62.12	21.09	16.79
			25 to last day	69.21	19.45	11.34
			Average:	49.03	24.27	26.70
V–32	3	36 days	1 to 5	11.45	43.11	45.44
			5 to 10	47.32	20.12	32.56
			10 to 15	58.11	31.00	10.89
			15 to 20	59.12	28.23	12.65
			20 to 25	68.99	23.45	07.56
			25 to last day	63.54	15.88	20.58
			Average:	51.42	26.97	21.61

Table A (Contd.)

Nest No.	No. of nestling	Nestling period	Days of nestling period	Percentage of food material:		
				Plant	Animal	Undetermined
V–32a	1	37 days	1 to 5	6.57	37.99	55.44
			5 to 10	41.77	27.11	31.12
			10 to 15	53.54	21.87	24.59
			15 to 20	56.70	25.12	18.18
			20 to 25	71.43	19.78	8.79
			25 to last day	65.98	17.37	16.65
			Average:	49.33	24.87	25.80
V–66	3	36 days	1 to 5	11.55	39.78	48.67
			5 to 10	39.98	26.25	33.77
			10 to 15	55.46	19.20	25.34
			15 to 20	65.23	22.13	12.64
			20 to 25	58.78	17.88	23.34
			25 to last day	67.00	18.77	14.23
			Average:	49.67	24.00	26.33

Table B

Percentage of food material fed by the parents during different nestling periods: *M. rubricapilla*

Nest No.	No. of nestlings	Nestling period	Days of nestling period	Percentage of food material:		
				Plant	Animal	Undetermined
R–4	2	36 days	1 to 5	19.11	7.12	83.77
			5 to 10	58.18	3.50	38.32
			10 to 15	79.67	5.12	15.21
			15 to 20	78.58	—	21.42
			20 to 25	88.18	—	11.82
			25 to last day	87.92	—	12.08
			Average:	68.60	2.62	30.45
R–9	2	35 days	1 to 5	11.23	27.45	61.32
			5 to 10	78.23	4.68	17.09
			10 to 15	71.00	—	29.00
			15 to 20	79.56	2.00	18.44
			20 to 25	92.34	—	7.66
			25 to last day	90.18	—	9.82
			Average:	70.42	5.69	23.89
R–12	2	36 days	1 to 5	17.88	21.89	60.23
			5 to 10	80.00	6.12	13.88
			10 to 15	87.77	2.34	9.89
			15 to 20	85.98	—	14.02
			20 to 25	91.00	1.78	7.22
			25 to last day	90.45	—	9.55
			Average:	75.51	5.34	19.13

TABLE B (Contd.)

Nest No.	No. of nestling	Average per hour between				
R–22	2	37 days	1 to 5	23.11	18.22	58.67
			5 to 10	79.24	3.78	16.98
			10 to 15	85.79	—	14.21
			15 to 20	78.98	2.01	19.01
			20 to 25	92.11	—	7.89
			25 to last day	89.99	0.25	9.76
		Average:		74.87	4.04	21.08

TABLE C

RATE OF NEST FEEDING/CLEANING DURING DIFFERENT HOURS AND DAY OF NESTLING PERIODS: *M. viridis*

Nest No.	No. of nestlings	Days	Average per hour visit by the parents between different hours			Ave. of whole day	Faecal matter removal per hr.
			6 to 10	10 to 14	14 to 18		
V–3	2	1 to 5	2.25	6.37	5.75	4.79	0.87
		5 to 10	6.25	9.25	6.50	7.75	1.16
		10 to 15	9.50	9.25	4.25	7.67	1.19
		15 to 20	10.30	10.00	7.50	8.80	1.91
		20 to 25	8.25	10.01	4.00	7.42	2.91
		25 to last day	9.75	9.80	5.75	8.43	3.50
	Average:		7.72	9.07	5.62	7.48	1.92
V–5	1	1 to 5	2.45	3.11	2.35	2.63	0.89
		5 to 10	2.99	3.00	3.00	3.00	1.05
		10 to 15	3.35	3.67	3.00	3.34	1.50
		15 to 20	3.98	3.87	3.77	3.87	2.00
		20 to 25	4.45	4.89	4.01	4.45	2.14
		25 to last day	4.97	4.25	4.00	4.40	2.77
	Average:		3.70	3.80	3.36	3.61	1.73
V–19	2	1 to 5	5.10	5.87	4.33	5.10	0.93
		5 to 10	7.11	8.98	6.34	7.48	1.71
		10 to 15	10.55	11.00	5.22	8.92	2.00
		15 to 20	10.78	11.76	7.13	9.89	2.45
		20 to 25	11.00	9.11	5.87	8.66	2.95
		25 to last day	10.89	10.00	6.12	9.00	4.00
	Average:		9.24	9.29	5.83	8.18	2.34

TABLE C (Contd.)

Nest No.	No. of nestlings	Days	Average per hour visit by the parents between different hours			Ave. of whole day	Faecal matter removal per hr.
			6 to 10	10 to 14	14 to 18		
V–30	3	1 to 5	6.00	6.21	4.88	5.70	1.00
		5 to 10	8.11	8.01	6.71	7.61	1.65
		10 to 15	8.98	8.00	7.78	8.25	2.11
		15 to 20	11.00	10.71	8.85	10.19	3.00
		20 to 25	10.89	11.01	7.67	9.89	3.01
		25 to last day	12.12	11.77	8.11	10.66	7.45
	Average:		9.51	9.29	7.37	8.71	3.03
V–32	3	1 to 5	7.89	6.01	5.00	6.30	1.11
		5 to 10	9.05	9.45	7.54	8.68	1.92
		10 to 15	9.00	10.12	8.13	9.08	2.24
		15 to 20	12.23	10.34	10.98	11.18	4.00
		20 to 25	15.00	12.98	10.00	12.66	6.93
		25 to last day	13.33	12.89	8.67	11.63	6.80
	Average:		11.08	10.30	8.39	9.92	3.83
V–32a	1	1 to 5	3.34	4.45	3.11	3.63	0.81
		5 to 10	5.88	5.95	4.85	5.56	0.98
		10 to 15	5.05	4.89	5.01	4.98	1.11
		15 to 20	7.76	8.00	6.12	7.29	2.89
		20 to 25	6.99	7.13	6.89	7.00	3.15
		25 to last day	7.98	6.91	5.97	6.95	4.00
	Average:		6.16	6.22	5.33	5.90	2.16
V–66	3	1 to 5	5.89	5.33	4.00	5.07	1.23
		5 to 10	8.88	9.11	7.98	8.66	2.01
		10 to 15	10.11	10.78	8.34	9.74	3.00
		15 to 20	13.26	12.55	10.15	11.99	4.85
		20 to 25	13.20	13.00	11.12	12.44	5.00
		25 to last day	12.92	13.45	10.98	12.45	6.89
	Average:		10.70	10.70	8.76	10.00	3.83

TABLE D

RATE OF NEST FEEDING/CLEANING DURING DIFFERENT HOURS AND DAY OF NESTLING PERIODS: *M. rubricapilla*

Nest No.	No. of nestlings	Days	Average perhour visit by the parents between different hours			Ave. of whole day	Faecal matter removal per hr.
			6 to 10	10 to 14	14 to 18		
R–4	2	1 to 5	3.25	4.10	2.27	3.20	1.20
		5 to 10	6.30	8.98	5.35	6.87	2.00
		10 to 15	9.77	8.89	7.98	8.88	2.65
		15 to 20	10.32	10.45	5.35	8.70	2.98
		20 to 25	10.04	11.10	7.88	9.67	3.24
		25 to last day	11.02	11.54	6.99	9.82	5.89
	Average:		8.45	9.16	5.97	7.86	2.99
R–5	2	1 to 5	3.76	3.25	2.87	3.29	1.65
		5 to 10	7.13	7.00	4.99	6.37	2.00
		Both the nestlings were thrown out by a pair of *M. viridis* on 13th day; see text.					
R–9	2	1 to 5	2.97	3.13	2.88	2.99	1.33
		5 to 10	6.76	6.66	5.11	6.18	2.35
		10 to 15	9.98	10.87	7.12	9.32	3.45
		15 to 20	9.76	11.23	8.34	9.77	3.23
		20 to 25	13.01	10.22	8.98	10.73	5.00
		25 to last day	12.91	11.00	7.98	10.63	5.15
	Average:		9.23	8.85	6.73	8.27	3.43
R–22	2	1 to 5	3.41	4.00	2.00	3.14	1.17
		5 to 10	7.01	6.25	5.98	6.41	2.35
		10 to 15	11.45	10.35	7.11	9.63	4.78
		15 to 20	10.00	9.87	7.00	8.95	4.00
		20 to 25	10.78	10.11	8.56	9.81	4.98
		25 to last day	11.25	10.56	8.34	10.05	5.15
	Average:		8.98	8.52	6.49	8.00	3.73

ing during the first 5-7 days was about 8-10 minutes per visit but later came down to 2-4 minutes per visit; when it rained the parents brooded for longer periods. After the 14th day of nesting period, parents of both species hardly ever brooded during the daytime, but females brooded at nights till the nestlings fledged.

Nestling period:

The nestling period is defined as the time from the day the last egg hatched until the nestlings fledged. Owing to their nidiculous nature, the nestling period in barbets is very long; in *viridis* it is 36-38 days, whereas in *rubricapilla* it is 35-37 days.

Growth rate:

Fig. 6 gives a comparison of weight changes in relation to age of the nestlings. The average weight increase per day per young in *viridis* and *rubricapilla* is 2.7 gm and 1.40 gm respectively. The weight of the nestlings increases up to the 21st day and gradually decreases afterwards up to the 27 day. It remains constant in the following 3-4 days. The weight of nestlings keeps increasing as long as the frequency of nest feeding increases. In another nest, the rate of weight-gain in the lone *viridis* was significantly higher and it continued to remain much heavier than the siblings sharing the other nests.

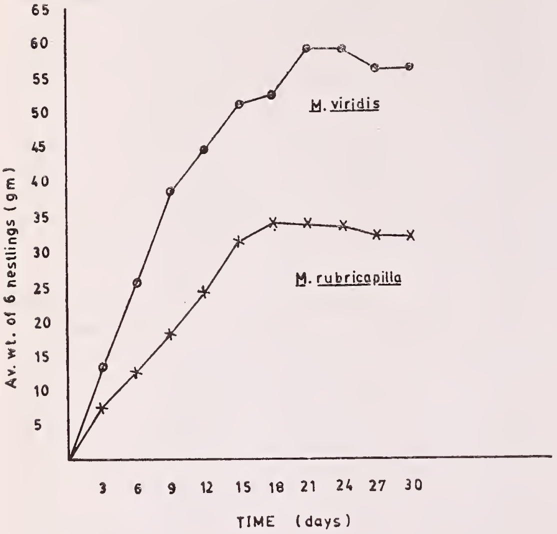

Fig. 6. Growth rate.

Morphological changes of nestlings such as growth of feathers have been described elsewhere (Yahya 1980).

Fledging and fledgling period:

Parent barbets were observed calling appreciably 2-3 days prior to fledging, apparently to lure the nestlings out of the nest. During this period the parents would not feed the nestlings in the normal way; rather they perch on a branch with the food, while nestlings look at them from the entrance, for a minute or two before feeding the nestlings. From each of the nests observed, all the nestlings of the brood fledged simultaneously. On all the occasions fledging took place between 0800 and 1000 hrs, except in one nest from which the single nestling fledged at 1445 hrs.

The fledgling period in barbets is very short; the parents guide and feed the fledglings for 2-4 days, after which the young and parents separated.

During the immediate post-fledging period parents keep a constant watch and feed their chicks regularly. In the evenings, they lead their nestlings back to the roost holes.

Orientation of young barbets:

During the study period, I banded 23 nestlings of *viridis* to monitor their activities after they had become independent. I located a few of them foraging on fruit trees in the following 8-10 days but gradually they all disappeared. During February and March, when the trees in this area undergo leaf-fall it is possible to see birds much more easily but, in spite of active search, I could not locate any of the banded young. As the young barbets were independent after their fledgling period it is hardly likely that all the colour-banded ones had died or been killed by predators. It is probable that, like many other birds the young barbets also disperse to other areas far from parental territories.

Breeding success and causes of nesting failure:

Owing to their hole-nesting behaviour, the level of breeding success in barbets is quite high, more than 50%. Although samples in Table 3 are not comparable, it appears that breeding success in *rubricapilla* is higher than in *viridis*.

Among 18 nests of *viridis* observed carefully, 6 eggs (two clutches) were predated, most probably by Three-striped Palm squirrels. One adult member of another pair with three eggs was killed by a shikra, and the mate then abandoned the nest. Three eggs, one each from three different clutches, did not hatch and the parents eventually threw them out. Out of 37 nestlings that hatched, 28 left the nest successfully; several died on days 1-3 of nesting period.

From a total of eight nests of *rubricapilla* observed, only one egg did not hatch; in this case parents incubated the single egg for 23 days and then abandoned the nest. At another nest, two *rubricapilla* eggs were thrown out by a pair of *viridis.* Of the 12 nestlings that hatched, 9 fledged successfully; two nestlings were thrown out by a pair of *viridis.*

Due to its habit of nesting in thinner branches *rubricapilla* loses some nests owing to rain/wind, whereas because of its low level nesting habit a few nests of *viridis* get destroyed by woodcutters. Another point worth mentioning is that while *viridis* usually leaves a number of nests uncompleted, *rubricapilla* hardly ever does so.

Successful Coexistence:

The study shows that *viridis* and *rubricapilla* coexist successfully at Periyar Tiger Reserve. Although *viridis* often harasses the nesting pairs of *rubricapilla,* scattering of the nest location of the latter may serve as an interspecific defence mechanism. The different nesting heights and different food material of the young also reduces competition. Further, *viridis* is larger than *rubricapilla* (almost double the size) and owing to its larger beak excavates a longer nest cavity in thicker branches.

As postulated by Huxley (1942) and supported by Lack (1971), a big size-difference between congeneric species of birds is a means of ecological isolation. During the comparative study of other species of barbets, I found *M. zeylanica* and *M. haemacephala* occurring together at Borivli National Park, Hazaribagh National Park and at the Betla Tiger Reserve; *M. lineata* and *M. haemacephala* coexist in Betiah Forests and at Corbett Tiger Reserve; and *M. asiatica* and *M. haemacephala* coexist in Botanical Garden, Calcutta. All the coexisting species have a remarkable difference in size — one large and one small. Thus it appears that the divergent morphological adaptation of two closely related species in a single habitat is a natural selection and helps in successful coexistence.

Although barbets appear to fare well at these places, removal of dead and dry branches by woodcutters has a detrimental effect on them. Moreover, gradual shrinkage of forest cover may also have a far reaching effect on the tree-hole nesters. Since barbets play a beneficial role in controlling various harmful insects, and in cross pollination and seed dispersal of plants (Yahya 1980, 1982), they deserve consideration in conservation strategies.

SUMMARY

The peak breeding season of *viridis* and *rubricapilla* ranges from January to May and almost all pairs complete their nesting activities before the onset of heavy rain.

Courtship display is very vocal; males of both species feed the females after copulation. Courtship feeding is also recorded during nest excavation.

Barbets select dead and dry branches for excavating nests; *rubricapilla* prefers thinner branches at much higher levels than *viridis.* Both species usually excavate a new nest each year but sometimes they use old roost-holes for nest sites.

Both species defend their nesting branches from other hole-nesting birds and from Three-striped Palm Squirrel. *M. viridis* is more tolerant to its own kind and several pairs may nest fairly close to each other. The nests of *rubricapilla* are more scattered. Sharing the same tree, even within the species, was not observed.

Duration of nest excavation, incubation, nestling and fledgling periods are similar in both the species. The larger beak of *viridis* enables it to excavate on an average a 32 cm-deep nest cavity in about 20 days, whereas *rubricapilla*, with its smaller beak, drills only about 17 cm deep nest cavity in *c.* 18 days. Some inexperienced pairs of *viridis* took as long as 52 days to complete the excavation.

The incubation period in both species lasts 14-15 days. The nestling period of *viridis* is 36-38 days, while that of *rubricapilla* is 35-37 days. Both species are determinate layers; some pairs of both species raise a second brood. Normal clutch size in *viridis* is 2 or 3, and in *rubricapilla* 1 or 2; eggs are laid consecutively, one egg each morning. In both species, diurnal incubation and brooding are performed by both parents, but during the night only the females incubate and brood. The percentage of attentiveness of the parents to incubation increases overtime and reaches its maximum 2-3 days prior to hatching. The parents are most attentive during morning hours and least attentive during afternoons. The parents also become more attentive when it rains and the ambient temperature falls.

Owing to their hole-nesting habits, breeding success is quite high in these congeneric barbets, being more than fifty per cent.

Ecological isolation for breeding between *viridis* and *rubricapilla* is manifested as differences in size, in nest-site selection and in the food of the nestlings. Fruits constitute the main food of the nestlings of *rubricapilla*, whereas *viridis* feeds its nestlings insects throughout the nestling period.

ACKNOWLEDGEMENTS

I express my most sincere gratitude to the late Dr. Salim Ali for his guidance, constant interest and constructive criticism at various stages of the study. Thanks are also due to the Bombay Natural History Society for financial assistance. Mr. J. C. Daniel, Dr. V. S. Vijayan, Mr. S. A. Hussain, Dr. Robert Grubh kindly visited the study area during the study period and provided valuable suggestion. I am grateful to Mr. Peter J. Garson for his suggestions during the preparation of this paper.

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LIFE HISTORY OF THE COMMON INDIAN TREE FROG, *POLYPEDATES MACULATUS* (GRAY, 1834) (ANURA: RHACOPHORIDAE)[1]

P. MOHANTY-HEJMADI AND SUSHIL K. DUTTA[2]

(*With nine text-figures*)

The breeding season of *Polypedates maculatus* coincides with the monsoons extending from May through September with a peak in June-July. Eggs are deposited in a foam nest near or above seasonal pools of water. The tadpoles take advantage of rain to drift into a suitable pool of water to complete development. Deposition of eggs away from water, hatching at a relatively late stage, fast growth and capacity to change colour at metamorphosis constitute the reproductive strategy of the species. Predation in few nests supports the premise that it is safer to deposit eggs away from water. Desiccation seems to be the major cause of larval mortality in tropical climate.

INTRODUCTION

Polypedates maculatus, the Indian tree frog is widely distributed in India (Dutta 1985). Common during breeding season, they are found throughout the year resting deep in the sheath of banana (*Musa paradisica, Musa sapientum*) or *Colocasia* plants, among damp vegetation on the ground and occasionally in residential areas (Mohanty-Hejmadi 1977*a*). Their habit of sitting motionless throughout the whole day on wooden doors and windows, has earned them the nickname "Katha Benga" or "Wood frog", in Oriya language. They are also known as "Akhi diyan Benga" in Oriya, meaning the "frog that leaps into the eyes of the observer" in the belief that these frogs can damage human eyes, obviously a misconception due to their remarkable leaping ability. Like most of the rhacophorids, they deposit their eggs in a foam nest attached to vegetation either above or near water. Since information on only a few larval stages is available (McCann 1932), this study was undertaken to obtain detailed information on their breeding habits and life history.

MATERIAL AND METHODS

Observations were made in the Vani Vihar campus area, Bhubaneswar located in 20° 21′ N lat. and 85° 53′ E long. from April, 1976 to September, 1977. This period includes two breeding seasons coinciding with the monsoons from May through September. Egg masses, either from nature or constructed by amplecting pairs in the laboratory, were set up at room temperature (30-35°C) under standardized conditions in the laboratory (Mohanty-Hejmadi 1977*b*), and the embryos were raised through metamorphosis. Parallel observations were made in nature. Eggs were extracted from the nest by the method recommended by Coe (1974) and the effectiveness of the method was determined by opening the extracted nest. The dome-shaped exposed area was measured as a function of size of egg mass. The length of femur bone was also taken as a measure of size of adults, as

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it proved to be more accurate than standard snout-vent length (Mohanty-Hejmadi 1977*a*). Percentage of hatching was determined by counting the hatched larvae and the remaining eggs or unhatched embryos inside the nest. The terminology of Webb & Korky (1977) was followed to determine the tooth row formula.

OBSERVATIONS

Spawning:

There was a distinct sexual dimorphism. The mean snout-vent lengths of breeding males and females were 53 (range 50-56) and 75 (range 73-79) mm respectively. The mean weights of breeding males and females were 7.7 g (range 6-9) and 19.4 g (18-22) respectively.

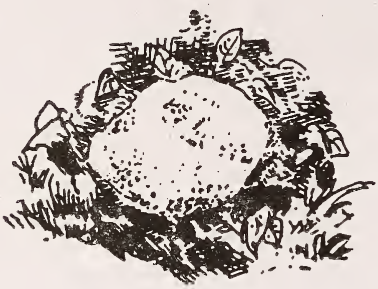
The breeding season extended from May to September coinciding with the monsoons, with a peak in June-July. The females deposited eggs in a foam nest attached to vegetation or under stones, usually well hidden but occasionally exposed, near water (Fig. 1). In one instance, five egg masses about 15 to 30 cm apart, were observed under stones. In a cement tank, a second nest was found in exactly the same spot, attached to aquatic vegetation approximately 12 cm above the water level, within one week of the removal of the first nest. Pairs collected in amplexus, laid eggs in foam nests in tin containers and corners of glass aquaria. The nests were always constructed 8 to 13 cm above water level. Both in nature and in the laboratory, the nests were constructed between midnight and early morning after rainfall. During oviposition, the female first secreted a jelly-like viscous fluid which was beaten into a froth by her hind limbs. This was followed by extrusion of a batch of eggs and more fluid, and beating. Thus eggs were laid and inseminated in batches. Occasionally the male moved its legs but did not take any active part in the nest building. After completion of nest building, the amplecting pair literally crawled out of the nest. In one instance, a female collected in amplexus but deserted by the male, constructed a normal foam nest but the eggs were inviable. Although the shape of the foam nest varied according to the substratum, they were oval in general. Initially, the foam nest was frothy white, the outer layer drying into a brownish crust. The inside of the nest deliquesced and remained moist for five to six days depending on the temperature and rainfall, long enough to support development of the larvae till hatching. When the nest was opened up for examination and pressed back together, it reconstituted without any ill effect on the embryos. Three out of forty egg masses observed in nature, were found floating on water in normal orientation obviously washed into the water by rain. When attempts were made to reverse the orientation, the egg mass returned to its normal orientation within a few seconds. The exposed surface of egg mass ranged from 95 to 120 mm. There was a direct correlation between egg mass size and number of eggs (Table 1) and between the size of female and the number of eggs (Table 2). Thus, fecundity was a function of size. The eggs were creamy white, 1.5 mm in dia-

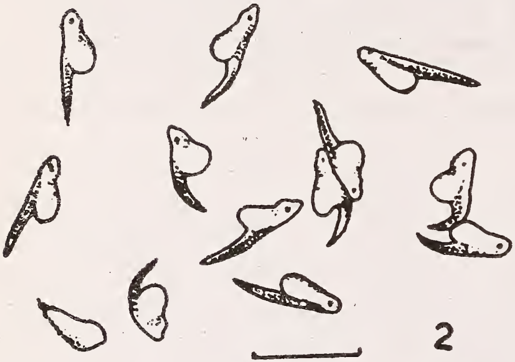
TABLE 1

RELATIONSHIP BETWEEN SIZE, EGG MASS AND NUMBER OF EGGS OF *Polypedates maculatus*

Female	Exposed area of egg mass (mm.)	Number of eggs
1	95	310
2	96	386
3	110	415
4	112	445
5	113	430
6	120	520

meter. The number of eggs in nine nests ranged from 275 to 719 (mean 454±123).





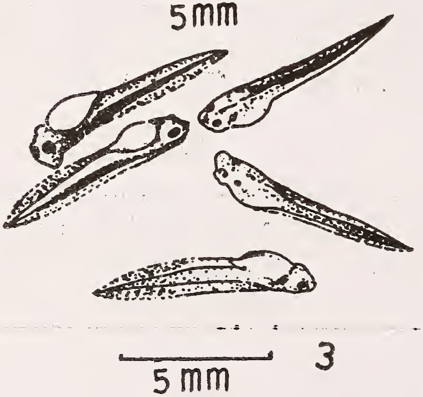
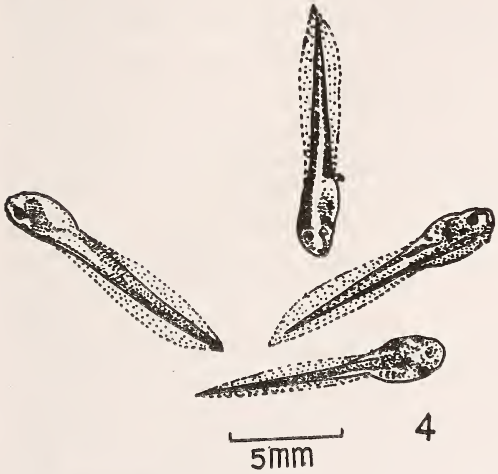


Fig. 1. Egg mass of *Polypedates maculatus*. Fig. 2. Primary hatching stage. Fig. 3. Secondary hatching stage.

Development and life history:

The embryos developed within the soft foam. There were two hatchings involved in the release of tadpoles from the nest, a primary one out of the fertilization membrane into the foam and a secondary one out of the nest. At primary hatching stage, the 4-4.5 mm tadpoles were white with a bulging yolk mass, translucent head and narrow tail (Fig. 2). They were capable of muscular movement at this stage. Attempts to raise these embryos in amphibian Ringer's solution were unsuccessful, indicating that further development was only possible inside the soft foam. Secondary hatching occurred at external gill stage. Pouring water over the nest at this stage deliquesced the foam and triggered the release of tadpoles, indicating that rain water probably acts as a stimulus for hatching out of the nest. Pigmentation appeared at this stage (Fig. 3). The gill circulation could easily be seen through the dorsum. The tadpoles remained at this stage inside the nest for a considerable time, waiting for the raindrops to carry them. If it did not rain for a whole day after the tadpoles reached this stage, the egg masses dried up with the tadpoles. In nature, a large number of nests dried up at this stage due to unusual dry spells. Exposed egg masses dehydrated faster than hidden ones.

Hatching continued from four to five days after oviposition. The percentage of hatching ranged from 89 to 100, with a mean of 96.4%. Tadpoles reached feeding stage with a tooth row formula of 2(1)/3 when about 11 mm (Fig. 4). By the time they reached 14 mm, they developed the characteristic suctorial mouth with a tooth row formula of 4(2-4)/3. The pigmentation continued to increase and a larva at this stage was gray with lateral eyes, a relatively long and muscular tail with a flagellum at the tip. Mostly foraging for food at the bottom, larvae also swim on the upper surface of water or can stay suspended effortlessly under water with the help of the flagellum. When offered vegetable matter and proteinaceous food (egg or dead larvae) they preferred the latter. The average number of days to complete metamorphosis was 55. The characteristic adult features such as the spots, wide mouth, pads on fingers and ability to change colour appeared at metamorphosis (Figs. 5-8). Development time in the laboratory (Table 3) was comparable to that in nature, but the laboratory raised larvae and juveniles were considerably smaller than those



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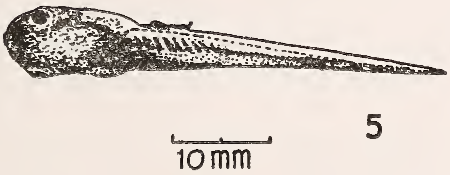

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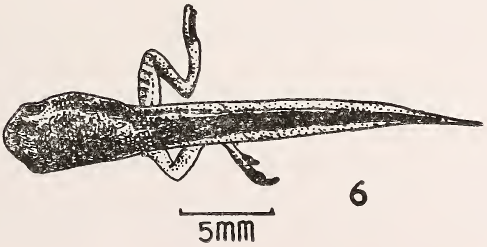

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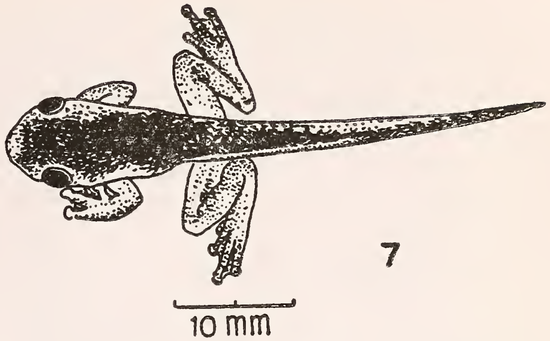
Fig. 4. Dorsal and ventral views of feeding stage. Fig. 5. Pre-metamorphic stage. Fig. 6. With well developed hind limbs.



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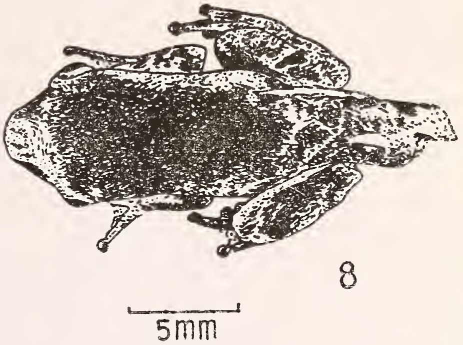

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Fig. 7. With fore-limbs. Fig. 8. Almost metamorphosed froglet.

TABLE 2

RELATIONSHIP BETWEEN SIZE OF FEMALE AND FECUNDITY OF *Polypedates maculatus*

Female	S-V. Length (mm.)	Femur length (mm.)	Weight (g)	No. of eggs
1	79	35	22	719
2	76	34	20	520
3	74	32	18	435

in size between hind limb and fore-limb
tiation of metamorphosis which started prior
to the appearance of fore-limbs, hence the loss
in nature. Growth was exponential till the ini-
stages (Fig. 9).

TABLE 3

AGE AND SIZE OF DEVELOPMENTAL STAGE OF *Polypedates maculatus*

Stage	Age	Size in mm.
Fertilized egg	0 hr	1.5
Primary hatching	24 „	3.0
Secondary hatching	4½ days	7.5
Operculum complete	5½ „	10.0
Feeding	6 „	11.0
Limb bud	35 „	22.0
Well developed hind limb	45 „	41.0
Four limbed	50 „	40.0
Metamorphosed froglet	55 „	16.0

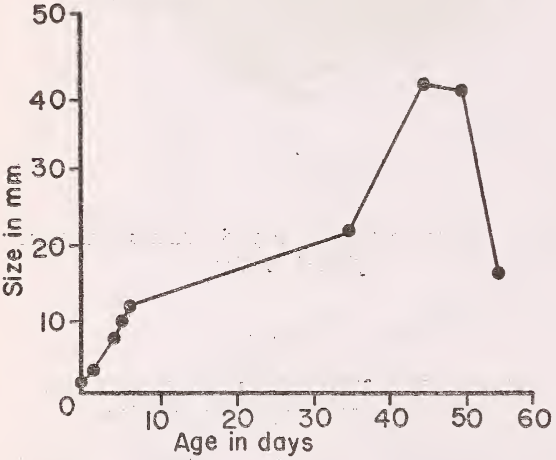

Fig. 9. Growth curve for *Polypedates maculatus* up to metamorphosis.

Predators:

Three out of forty egg masses observed in nature were infested with larvae of Tabanidae family (Diptera). The larvae devoured all the eggs and took advantage of the moist nest to complete their life cycle. Obviously the fly had deposited eggs in the nest. Tadpoles were eaten by larvae and adults of the common water bug, *Belostoma.*

DISCUSSION

The breeding habits and strategy of reproduction is typical of members of Rhacophoridae (Noble 1954, Cochran 1967, Coe 1974). The relatively short period of development is characteristic of tropical species which have to take advantage of transitional aquatic habitats during the monsoons (Heyer 1973). Deposition of eggs away from water protects the early stages of the embryos. Predation in relatively few nests supports this premise. Hatching out at a mobile stage puts the larva at a further advantage. The size of the egg and consequently the larva at hatching are much larger than those of all other species of anurans common to this area (unpublished results). In addition, the larva is a powerful swimmer with a long, muscular tail and lateral eyes which are adaptations for escaping predators and also locating food. The powerful teeth and suctorial mouth enable the larva to consume food almost continuously, which is reflected in its exponential growth. The metamorphosed froglet has the ability to change colour, which must contribute further to its survival.

Unusual dry spells during monsoon season are the major cause of larval mortality whether eggs are deposited in or out of water, because the progeny of the species which spawned in water also suffered a similar fate. The possibility of physical factors other than predation selecting for rapid development, has been discussed in detail by Wassersug (1975). Since desiccation was the major cause of reduction in the population, it is concluded that in tropical climate with a clearly defined monsoon season, desiccation is the major selective factor for fast development.

This study also agrees with the findings of McCann (1932), except in the following points. Based on the construction of a foam nest by a female in captivity and development of eggs, McCann (1932) put forward several reasons in favour of the difficulty in supporting a male on the back and believed that the female carried the sperms on the back. In this study, foam nests were constructed in places similar to those in nature, above water almost instinctively in various places, by pairs in amplexus (except one). In the latter, the female made a perfect nest but the eggs were inviable. Many times during the foam beating process the smaller male was buried and hardly noticeable in the foam; this might be the reason why McCann (1932) did not notice the male. Also, he did not observe the external gills at hatching (out of the nest) stage probably because they are rather transparent and inconspicuous at this stage.

ACKNOWLEDGEMENT

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NEW RECORDS FOR MAHARASHTRA[1]

S. M. Almeida[2] and M. R. Almeida[3]

Polygalaceae

1. **Salomonia oblongifolia** DC. Prodro. 2: 354, 1825; FBI 1: 207, 1874. *S. sessilifolia* Ham. in Don Prodr. Fl. Nep. 201; 1825. *S. obovata* Wight, Ill. t. 228, 1840. *Figure*: Wight, l.c.

Rare herb among grasses.

Flowering & Fruiting: August-September. *Localities*: Charatha, Bhedsi, Majgaon-Savantwadi. *Exsiccata*: SMA — 305, 2549, 2964.

Note: Kartikeyan *et al.* in the Chapter on "additions to Cooke's Flora" in the records of the Botanical Survey of India, Vol. 21 (2): 158, 1981 mention the occurrence of this species from North Kanara. Blatter Herbarium has a few herbarium sheets of this species from Sampkhand, Sidharpur (N. Kanara) collected by Hall. & McCann (No. 35146, 35083) and from Karwar by L. J. Sedgwick (No. 6656).

Malvaceae

2. **Abutilon hirtum** (Lamk.) Sweet. Hort. Brit. 53, 1826; Meeuse, Exell. & Wild. Fl. Zamb. 1: 487, t. 93, f.f. 1-2, 1957. *Sida hirta* Lamk. Encycl. 1: 7, 1783. *Sida graveolens* Roxb. ex Hornem. suppl. Hort. Bot. Hafn. 77, 1819. *Abutilon graveolens* (Roxb. ex Hornem.) Wt. & Arn. Wight, Cat. Pl. 13, 1833; Prodr. 56, 1834; Cooke, 1: 97 (103), 1901. *A. graveolens* Wt. & Arn. var. *hirtum* Masters, Fl. Brit. Ind. 1: 327, 1874. *Figure*: Meeuse, l.c.

Rare herb of waste-lands.

Flowering: January. *Localities*: Burdikolgaon, Banda-Satarda-Savantwadi, Nagpur, Ahmednagar. *Exsiccata*: SMA — 4182, 4343.

Note: T. Cooke in 'The Flora of Bombay Presidency' mentioned the occurrence of this species from Sind.

There are few herbarium specimens of this species (No. 1912, 2115, 3609) in Blatter Herbarium collected from Dharwar by E. J. Sedgwick & from Nellore Cuddapah, A. P. collected by S. K. Wagh (6760, 6606, 7564). These localities are not within the limits of Maharashtra. There are 2 specimens collected from Maharashtra; one from Nagpur collected by M. Mirashi (242) and the other from Ahmednagar collected by R. D. Acland (53).

Sterculiaceae

3. **Pterospermum acerifolium** Willd. Sp. Pl. 3: 729, 1800; Graham Cat. 20, 1839; FBI 1: 368, 1874; K. Schum in Engl. & Prantl. Pflanzenf. 3(5): 93, f. 48 H, 1890; Dalgado, 23, 1898; Cooke, 1: 129 (37), 1901. *Figure*: K. Schum. l.c.

A common tree in evergreen patches of forests.

Flowering: December-March. *Localities*: Amboli, Bhedsi, Malgaon-Savantwadi. *Exsiccata*: SMA — 4057; BGK — 119485-C; MRA — 2382A (ALC).

Note: T. Cooke in 'Flora of the Presidency of Bombay', comments about this species as an extensively planted but of doubtful occurrence in nature; Stocks gives konkan as its habitat without any specific locality. John Graham and R. H. Beddome mentioned it as being grown

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[1] Accepted January 1986.

[2] Blatter Herbarium, St. Xavier's College, Bombay 400 001.

[3] Alchemie Research Centre, Thane-Belapur Road, Thane.

in gardens. We have collected the species from evergreen forests at Amboli and Malgaon, from Sindhudurg district.

TILIACEAE

4. **Grewia heterotricha** Masters, in Flora Brit. Ind. 1: 385, 1874; Cooke, 1: 139 (148), 1901.

A scandent shrub, rare in forest area.

Flowering: November. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 196.

Note: T. Cooke in 'Flora of Bombay Presidency' mentioned Kanara as the locality for this species. There is no earlier report of this species from Maharashtra.

RUTACEAE

5. **Clausena indica** (Dalzell) Oliver, J. Linn. Soc. Bot. 5 (suppl. 2): 36, 1860; FBI 1: 505, 1875; Cooke, 1: 184 (194), 1901. *Piptostylis indica* Dalzell, Kew Journ. Bot. 3: 33, t. 2, 1851. *Figure*: Dalzell, l.c.

Rare tree at Amboli.

Flowering: March-May. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 4743; MRA — 586, 988 (ALC).

Note: This species has been reported from N. Kanara by T. Cooke.

CELASTRACEAE

6. **Cassine paniculata** (Wight & Arn.) Ramamoorthy, in Fl. Hassan Dist. 318, 1976. *Elaeodendron paniculatum* Wight & Arn. Prodr. 157, 1834; FBI 1: 609, 1878.

Large tree. Leaves ovate-lanceolate, acuminate, crenate, turns black when dry. Flowers in axillary, dichotomously branched cymes with solitary flower at the fork of the dichotomies. Fruit drupe, fleshy, globose.

A common tree on the Plateau and along the ghats.

Flowering: April-May. *Localities*: Amboli, Chaukul, Ramghat-Savantwadi. *Exsiccata*: SMA — 3202, 3973, 4062; Cherian — 102270 (BSI); Pataskar — 105284 (BSI); MRA — 469 (ALC).

Note: This is the first report of this species from Maharashtra and this species is also an addition to Cooke's Flora.

7. **Euonymus indicus** Heyne ex Roxb. Fl. Ind. 2: 409, 1824; FBI 1: 608, 1875; Cooke 1: 228 (242), 1902. *E. gaughii* Wight, Icon. t. 215, 1839; Ill, 178, 1850; Dalz. & Gibs. 47, 1861. *Figure*: Wight, l.c.

Common tree at Amboli near Hiranyakeshi and in the evergreen forests.

Flowering: December-February. *Localities*: Amboli, Ramghat, Chaukul, Bhedsi, Hiranyakeshi-Savantwadi. *Exsiccata*: SMA — 1330, 4117; BGK — 10860, 119186 (BSI); MRA — 442 (ALC).

Note: T. Cooke mentions Kanara as the locality for this species.

8. **Ampelocissus tomentosa** (Roth.) Planch. in Journ. Vigne Amer. 375, 1884; Gamble, Fl. Madras, 230 (165), 1915. *Vitis tomentosa* Heyne ex Roth. Nov. Pl. Sp. 157, 1821; FBI 1: 650, 1875; Cooke, 1: 252 (268), 1902.

A rare climber among hedges.

Flowering & Fruiting: March-August. *Local name*: Shendvel. *Locality*: Aronda-Savantwadi. *Exsiccata*: SMA — 618.

Note: T. Cooke reported this species from Belgaum, Dharwar and North Kanara.

FABACEAE

9. **Centrosema pubescens** Benth. in Ann. Wien. Mus. 2: 119, 1838; Van Steenis & Jacobs, in Fl. Mal. Bull. No. 18, 1089, 1963. *C. virginianum* Sensu, Subramanyam, in Bull. Bot. Surv. India, 3(2): 201-203,

t. 1, 1961 [(non Linn.) Benth. 1937]. *Figure*: Subramanyam, l.c.

A twiner, along the margins of forests. Rare. *Flowering & Fruiting*: July-August. *Localities*: Amboli, Charatha-Savantwadi. *Exsiccata*: SMA — 2371, 4139, 4479.

Note: Subramanyam has reported this species from Tenmalai Forest in Kerala State. This is the first report of this species from Maharashtra and the species is an addition to Cooke's Flora.

10. **Crotalaria prostrata** Rottl. in Willd. Enum, Hort. Berol. 744, 1809; FBI 2: 67, 1876; Cooke, 1: 293 (312), 1902.

Common herb among the grasses.

Flowering & Fruiting: October-December. *Localities*: Insuli, Amboli, Aronda, Burdi, Sonurli-Banda, Madkhol-Savantwadi. *Exsiccata*: SMA — 1021, 1202, 1248, 3374, 4294, 4489; BGK — 119329 (BSI).

Note: T. Cooke reported this species from Dharwar & Kanara.

11. **Derris benthamii** (Thwaites) Thwaites, Enum. Pl. Zeyl. 413, 1864; Thothathri, in Bull. Bot. Surv. India, 3: 186, 1961. *Brachypterum benthamii* (Thwaites, Ibid. 93, 1859. *D. paniculata* Benth. in Journ. Linn. Soc. 4: suppl. 105, 1860; FBI 2: 242, 1878.

A rare climber in forest areas.

Flowering & Fruiting: April-September. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 733.

Note: This species has been reported from South India by Thothathri.

12. **Derris canarensis** (Dalzell) Baker, in Fl. Brit. Ind. 2: 246, 1878; Thothathri, in Bull. Bot. Surv. Ind. 3: 190, 1960; Cooke, 1: 406 (433), 1902. *Pongamia canarensis* Dalzell. in Hook., Journ. Bot. 2: 37, 1850. *Brachypterum canarense* Dalz. & Gibs. Bombay Fl. 76, 1861. *Derris oblonga* Bth. in J. Linn. Soc. 4 (suppl.) 112, 1859; FBI 2: 242, 1878.

Climbing shrub in forest areas.

Flowering & Fruiting: February-May. *Localities*: Amboli, Insuli-paga, Danoli, Bhedsi-Ainoda-Savantwadi. *Exsiccata*: SMA-1505, 1579, 1631, 4188, 4210, 4544, 4787; BGK — 129373 (BSI); MRA — 998, 2001 (ALC).

Note: T. Cooke mentioned Kanara as the locality for this species.

13. **Derris macrocarpa** Thothathri, Bull. Bot. Surv. Ind. 3 (2): 192-3, t. 9, 1961. *Figure*: Thothathri, l.c.

Shrubby climber, rare in forest areas.

Fruiting: April-May. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 1538.

Note: Thothathri has reported this species from Uttar Pradesh.

14. **Desmodium heterophyllum** (Willd.) DC. Prodr. 2: 334, 1825; FBI 2: 173, 1876. *Hedysarum heterophyllum* Willd. Sp. Pl. 3: 201, 1800. *D. triflorum* var. *major* Wight & Arn. Prodr. 229, 1834; Wight, Icon. t. 291, 1840. *Figure*: Wight, l.c.

Copiously branched, procumbent, pubescent herb. Leaves trifoliolate, Corolla pink. Pods on slender stalk, indented on one suture, 2-6 jointed, black when dry.

A rare herb. Grows on sloping walls in shade near waterfalls.

Flowering & Fruiting: September-December. *Locality*: Otavane-Savantwadi. *Exsiccata*: SMA — 3221, 3577, 3909.

Note: This species is an addition to Cooke's Flora. In the Blatter Herbarium there are a few sheets of this species collected from Karwar by Hallberg & McCann (No. 34232, 34237) and from Dharwar collected by L. J. Sedgwick (4470).

MELASTOMATACEAE

15. **Memecylon heyneanum** Benth [in Wall. Cat. No. 4102, 1828 (nom. nudum) ex Wight & Arn. Prodr. 319, 1834: FBI 2: 560, 1879; Gamble, Fl. Madras 1: 503 (355), 1915. *M. jambosides* Wight, Icon. t. 277, 1840. *Figure*: Wight, l.c.

A rare tree of forest areas. Leaves lanceolate, acuminate. Umbels on older branches below the leaves. Flowers blue. Berry spherical.

Flowering & Fruiting: September-November. *Locality*: Virdi-Telekhol-Savantwadi. *Exsiccata*: SMA — 4917.

Note: This species is an addition to Cooke's Flora.

16. **Memecylon randeriana** nom. nov. *Memecylon malabaricum* Cogn. in DC. Monog. Phan. 7: 148, 1891 (non Kostel, 1834); Cooke, 1: 503 (535), 1903. *M. amplexicaule* Roxb. var. *malabarica* Wight, Icon. t. 279, 1840; FBI 2: 559, 1879. *Figure*: Wight, l.c.

A rare plant, of evergreen forests.

Flowering & Fruiting: March-May. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 3873, 4073.

Name: The name accepted for this species by earlier authors *Memecylon malabaricum* Cogn. (1891) is the later homonym of *M. malabaricum* Kostel (1834). Therefore the new name is proposed here after Dr. (Mrs.) A. R. Daruwalla (*nee* Aban Randeria) for her monographic contributions to the genus *Blumea* DC.

T. Cooke reported N. Kanara as the locality for this species.

LYTHRACEAE

17. **Rotala decussata** DC. Prodr. 3: 76, 1828; Hiern, in Oliv. Fl. Trop. Africa 2: 467, 1868. *R. illecebroides* Koehne, Bot. Jahrab. 1: 161, 1880; Pflanzen Luth. 34, 1903; Gamble, Fl. Madras 1: 508 (358), 1911. *Ammannia pentandra* var. *illecebroides* Arn. ex Clerke, in Fl. Brit. Ind. 2: 569, 1879.

Scarcely branched slender herb. Leaves ovate-cordate, single nerved. Flowers small, sessile in compactly arranged, bracteate, terminal spikes. Calyx lobes transparent, appendiculate, long-acuminate. Capsule 4-valved.

A rare herb in moist places and in waterlogged areas.

Flowering: September-October. *Locality*: Chaukul-Savantwadi. *Exsiccata*: SMA — 1978, 3200.

Note: This species is an addition to Cooke's Flora.

18. **Rotala fimbriata** Wight, Icon. t. 217, 1839; Koehne, in Engl. Bot. Jahrab. 1: 166, 1880; Pflanzen. Luth. 37, 1903; Gamble, Fl. Madras 1: 508 (359), 1911. *Ammannia pentandra* var. *fimbriata* Clarke, in Fl. Brit. Ind: 2: 568, 1879. *Figure*: Wight, l.c.

A rare herb in rice-fields.

Flowering: September-October. *Locality*: Usap-Savantwadi. *Exsiccata*: SMA — 1930, 3512, 3885, 4951, 4660; MRA — 838 (ALC).

Note: Kartikeyan *et al.* in records of Botanical Survey of India, mentioned Goa and N. Kanara as localities for this species.

19. **Mollugo cerviana** (Linn.) Ser. in DC. Prodr. 1: 392, 1824; FBI 2: 663, 1879; Cooke, 1: 559 (594), 1903. *Pharnaceum cerviana* Linn. Sp. Pl. 272, 1753.

Rare herb of cultivated fields.

Flowering: September-November. *Locality*: Aronda-Savantwadi. *Exsiccata*: SMA — 3351.

Note: T. Cooke mentioned Gujarat as the locality for this species.

20. **Alangium salvifolium** (Linn. f.) Wangerin, ssp. **hexapetalum** (Lamk.) Wangerin, in Engl. Pflanzen. 4(2206): 9, 1910; Blocmb.

in Blumea 1(2): 250, 1935. *A. hexapetalum* Lamk. Encycl. Meth. Bot. 1: 175, 1783. *A. sundarum* Miq. Fl. Ind. Bot. 1 (1): 774, 1856. *A. glandulosum* Thw. Enum. 133, 1859. *A. lamarkii* var. *glandulosum* (Thw.) Clarke, in Fl. Brit. Ind. 2: 742, 1879; Mukerjee, in Bull. Bot. Surv. Ind. 10: 330-31, 1968.

Scandent shrub. Leaves oblanceolate, 3 nerved from base. Flowers axillary, solitary, white, scented.

In forested areas. Rare.

Flowering & Fruiting: April-May. *Locality*: Malgaon-Savantwadi. *Exsiccata*: SMA — 2748, 4268, 4429, 4937, 4947.

Note: This sub-species is an addition to Cooke's Flora.

21. **Borreria ocymoides** (Burm. f.) DC. Prodr. 4: 544, 1830; Gandhi, in Fl. Hassan Dist. 574, 1976. *Spermacoce ocymoides* Burm. f., Fl. Ind. 34, t. 13, f. 1, 1768; FBI 3: 200, 1881. *Figure*: Burm. f., l.c.

Erect, branched herb. Leaves elliptic-ovate, decurrent at base. Flowers tiny, clustered within the axil of stipular cup.

Quite common herb in open places.

Flowering: August-September. *Localities*: Charatha, Amboli-Savantwadi. *Exsiccata*: SMA — 316, 354, 2811, 3117, 3424.

Note: This species is an addition to Cooke's Flora.

22. **Neanotis monosperma** (Wall. ex Wight & Arn.) W. H. Lewis, in Ann. Missouri, Bot. Gard. 53: 39, 1966. *Hedyotis monosperma* Wall. ex Wight & Arn. Prodr. 410, 1834. *Oldenlandia mysorensis* Wall. ex G. Don, Gen. Syst. Gard. Bot. 3: 531, 1834. *Anotis monosperma* (Wall. ex Wight & Arn.) Hook. f. Fl. Brit. Ind. 3: 75, 1880.

An erect, sparingly branched, glabrous herb. Leaves ovate, acuminate. Flowers in terminal compound cyme.

A common herb of road-sides and along the margins of forests.

Flowering & Fruiting: September. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 724, 1951, 3052.

Note: This species is an addition to Cooke's Flora.

23. **Oldenlandia diffusa** (Willd.) Roxb. Hort. Bengal, 11, 1814 (nom. nud.) Fl. Ind. 1: 423, 1820; FBI 3: 65, 1880; Cooke, 1: 589 (2: 16), 1903; Blatter & McCann in Journ. Bombay nat. Hist. Soc. 36(4): 784, 1933. *Hedyotis diffusa* Willd. Sp. Pl. 1: 566, 1798.

A diffuse prostrate herb. Leaves simple, opposite, sub-sessile, linear or linear-lanceolate, acute, glabrous. Flowers solitary, white. Capsule globose. Seeds angular.

A common plant in rice-field, in wet soils and along river-banks.

Flowering: April-December. *Localities*: Charatha, Insuli, Otavane, Amboli, Danoli-Savantwadi. *Exsiccata*: SMA — 145, 297, 1427, 1852, 1917, 1952, 3783, 3813, 4286.

Note: T. Cooke reported this species from S. M. Country, Belgaum & Kanara. Blatter & McCann l.c. eventhough they included this species did not give a locality.

24. **Phyllocephalum ritchiei** (Hook. f.) Almeida comb. nov. *Centratherum ritchiei* Hook. f. in Fl. Brit. Ind. 3: 228, 1881; Cooke, 2: 7(62), 1904.

A common herb among undergrowth in shade.

Flowering & Fruiting: September-January. *Localities*: Charatha, Amboli-Savantwadi. *Exsiccata*: SMA — 972, 1419, 1174, 2321, 4871; MRA — 964 (ALC).

Note: T. Cooke mentioned S. M. Country, Londa & Kanara as the localities for this species.

25. **Launea obtusatus** (DC.) Mundhe et Almeida comb. nov. *Brachyramphus obtusus* DC. Prodr. 7: 177, 1838 & in delessert. l.c. Scl. Pl. 4: 41, t. 96, 1840. *L. nudicaulis* Sensu auct. Plur (India), non *L. nudicaulis* L. Mant. 273, 1767. *L. procumbens* (Roxb.) Rammayya & Rajagopal, in Kew Bull. 23: 465, 1969 (non Amin 1956). *Prenanthes procumbens* Roxb. Fl. Ind. 3: 404, 1832. *Figure*: DC., l.c.

Procumbent herb, rooting at nodes.

In sandy soils. Rare.

Flowering: November-December. *Locality*: Aronda-Savantwadi. *Exsiccata*: SMA — 4270 A; MRA — 600 (ALC).

Note: Ramayya & Rajgopal (l.c.) proposed a new combination for this taxon. But the combination proposed had been used already.

OLEACEAE

26. **Jasminum angustifolium** (Linn.) Vahl Enum. 1: 29, 1804; Wight, Icon t. 1843; FBI 3: 598, 1882. *Nyctanthes angustifolia* Linn. Sp. Pl. 8, 1753. *Figure*: Wight, l.c.

Wiry climbing shrub. Leaves opposite, ovate-lanceolate, glabrous, entire, Flowers white, 1-3 on slender, pedicels on terminal cyme. Corolla lobes lanceolate, acuminate. Fruit ellipsoid.

Common twiner in semi-shaded forest areas.

Flowering: September-December. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 2658. *Note*: This species is an addition to Cooke's Flora.

27. **Jasminum ritchiei** C. B. Clarke, in Hook. f. Fl. Brit. Ind. 3: 598, 1882; Woodrow, in Journ. Bombay nat. Hist. Soc. 12: 164, 1898; Cooke, 2: 113 (174), 1904.

Common twiner of semi-shaded forest areas. *Flowering*: August-October. *Localities*: Amboli, Hiranyakeshi, Nangartas-Savantwadi. *Exsiccata*: SMA — 4114; MRA — 1274, 2569 (ALC); BGK — 108683 (BSI).

Note: T. Cooke reported this species from S. M. Country. There are a few sheets of this species in Blatter Herbarium from North Kanara collected by H. Santapau (18754-5); & Sedgwick (3238).

GENTIANACEAE

28. **Exacum axillare** Thw. Enum. Pl. Zeyl. 203, 1860; FBI 4: 96, 1883.

Procumbent or erect herb. Leaves ovate-lanceolate, long-petioled, 3-nerved. Flowers solitary on axillary peduncles.

Rare herb of open grasslands.

Flowering: September-October. *Locality*: Zolambe-Savantwadi. *Exsiccata*: SMA — 3468. *Note*: This species is an addition to Cooke's Flora.

29. **Exacum sessile** Linn. Sp. Pl. 112, 1753; Wight, Icon. t. 1324 (1), 1848; FBI 4: 98, 1883; Ramamoorthy, in Fl. Hassan Dist. 426, 1976. *Figure*: Wight, l.c.

Slender, erect herb. Leaves small, sessile, ovate. Flowers solitary in axillary and terminal peduncles.

Herb among grasses. Rare.

Flowering: October-November. *Localities*: Malgaon, Charatha-Savantwadi. *Exsiccata*: SMA — 3199, 3868, 3949.

Note: This species is an addition to Cooke's Flora.

30. **Hoppea fastigiata** (Griseb.) C. B. Clarke in J. Hooker, Fl. Brit. Ind. 4: 100, 1883; Gamble, Fl. Madras 2: 877 (616), 1923; Ramamoorthy, in Fl. Hassan Dist. 456, 1976. *Cicendia fastigiata* Griseb. Gentia 158, 1839; DC. Prodr. 9: 62, 1846.

Small erect herb upto 10 cm high. Stem

4-winged. Leaves ovate, subsessile. Flowers axillary and terminal; peduncles clustered.

Among grasses. Rare.

Flowering: October-November. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 5072; MRA — 1624 (ALC).

Note: This is the first report of the species from Maharashtra.

CONVOLVULACEAE

31. **Ipomoea trichosperma** Blume, Bijid. 710, 1825; FBI 4: 198, 1883. *Calonyction trichospermum* Choisy, Convolv. 60, 1834; DC. Prodr. 10: 346, 1846.

Rare, woody twiner. Noticed only at one spot along the forest border and among bushes near a river bank.

Flowering & Fruiting: March-April. *Locality*: Banda, Satarda-Savantwadi. *Exsiccata*: SMA — 4194.

Note: This species is an addition to Cooke's Flora. There are a few herbarium sheets of the species in Blatter Herbarium from N. Kanara (1686-9) and (1871-6) collected by V. M. Patel and McCann, respectively.

32. **Lindernia pusilla** (Willd.) Bolding, Zakfl. Landbowster, Java, 165, 1916; Philocox, Kew Bull. 22: 41, 1968; Saldanha, Fl. Hassan Dist. 523, 1976. *Gratiola pusilla* Willd. Sp. Pl. 1: 105, 1797. *Torenia hirta* Cham. & Schlecht. Linnaea 2: 511, 1827. *Lindernia hirta* (Cham. & Schlt.) Pennell, Journ. Arn. Arbor. 24: 250, 1943; Mukerjee, Journ. Ind. Bot. Soc. 24: 131, 1945.

Prostrate hirsute herbs. Leaves sessile, ovate-orbicular, serrate. Flowers axillary, solitary or in terminal racemes. Corolla white with yellow upper lip.

Common in partially shaded wet places.

Flowering: May-July. *Localities*: Charatha-Savantwadi. *Exsiccata*: SMA — 141, 147, 2380, 4669; MRA — 1150 (BLAT).

Note: This species is an addition to Cooke's Flora.

33. **Lindernia rotundifolia** Alston var. **concanensis** Saldanha, Taxonomic Rev. Scroph, Western Peninsul. Ind. 1: 184, 1963 (inedit).

Differs from the typical variety by its tiny flowers which never exceed 4 mm in length.

Rare weed of wet soils.

Flowering: August. *Locality*: Charatha-Savantwadi. *Exsiccata*: SMA — 346.

Note: In Blatter Herbarium there are a few herbarium sheets of this species collected from Katta-Ratnagiri (6967-69, 7097-98); Ratnagiri (7140-42); Malvan (6989-94) by C. Saldanha.

34. **Lindernia tenuifolia** (Colsm.) Alston, in Trimen. Hand-Bk. F. Cey. 6: 214, 1931; Mukerjee in Journ. Ind. Bot. Soc. 24: 134, 1945. *Gratiola tenuifolia* Colem. Prodr. Descrip. Grab. 8, 1793; Vahl Enum. Pl. 1: 95, 1805. *Bonnaya tenuifolia* Spreng. Syst. 1: 42, 1825; FBI 4: 286, 1884. *B. pusilla* Griff. Notul. 4: 107, 1854 [non *Lindernia pusilla* (Willd.) Boldingh. 1916]. *Figure*: Matthew, Fl. Tamil Carn. 2: t. 500, 1982.

Rare herb. Grows among grasses.

Flowering: August. *Locality*: Aronda-Savantwadi. *Exsiccata*: SMA — 566; MRA — 613 (BLAT).

Note: This species is an addition to Cooke's flora. In Blatter Herbarium there are a number of herbarium specimens collected from various parts of Bombay and outside Bombay. [(Madh-Island-Saldanha (1361, 5745-48, 6617-20), Santapau (21301, 23509), Shah (7122-23, 7375, 7971); Ratnagiri-Malvan: Saldanha (7767); Thane-Mumbra: Shenoy — (390)].

35. **Microcarpaea minima** (Koenig) Merrill, in Philipp. Journ. Sc. Bot. 7: 100, 1912;

Fischer, in Kew Bull. 1932: 6, 1933. *Paederota minima* Koenig, in Retz. Obs. 5: 10, 1789. *M. alterniflora* Blume, Bijdr. 744, 1825. *M. muscosa* R. Br. Prodr. 436, 1810. *Figure*: Matthew, Fl. Tamil. Carn. 2: t. 502, 1982.

Common herb of drying rice-fields and of marshes.

Flowering: May. *Locality*: Otavane-Savantwadi. *Exsiccata*: SMA — 28, 4610, 4612.
Note: Kartikeyan *et al.* in Rec. Bot. Surv. India 21(2): 1981 mentioned North Kanara as the locality for this species. In Blatter Herbarium there are a few sheets of this species from Ratnagiri, collected by Saldanha (6970); from Malvan by Saldanha (6998-99); Satara-Mahableshwar, by Santapau (23432-33).

36. **Torenia lindernioides** Saldanha, in Bull. Bot. Surv. Ind. 8: 129, t. 4, 1966 & Fl. Hassan Dist. 527, 1976. *Figure*: Saldanha, l.c.

Common herb of open grasslands and laterite soils.

Flowering: May-August. *Localities*: Aronda, Charatha-Savantwadi *Exsiccata*: SMA — 43, 388, 627-A.
Note: This species has been reported from N. Kanara by C. J. Saldanha.

37. **Torenia thouarsii** (Cham. & Schlecht.) U. Kuntze, Rev. Gen. Pl. 2: 468, 1891. *Nortenia thouarsii* Cham & Schlecht. in Linnaea 3: 18, 1828. *Torenia parviflora* Buch.-Ham. ex Bth., Scroph. Ind. 39, 1835 & in DC. Prodr. 10: 419, 1846; FBI 4: 278, 1884.

Rare herb. Grows in wet fields.

Flowering: September-October. *Localities*: Charatha, Majgaon-Savantwadi. *Exsiccata*: SMA — 2050, 3804.
Note: Kartikeyan *et al.* in Rec. Bot. Surv. Ind. 21(2): 1981, have mentioned North Kanara, as the locality for the species.

38. **Torenia vagans** Roxb. Fl. Ind. 3: 96, 1824; FBI 4: 277, 1884; Gamble, Fl. Madras 2: 671, 1956. *T. diffusa* Don Prodr. 86, 1925. *T. hians* Roxb. Fl. Ind. 3: 96, 1874.

Diffuse trailing and rooting herb. Stem 4-sided. Flowers axillary, solitary on long peduncles.

Fairly common herb in wet soils in shady places.

Flowering: May-September. *Localities*: Malgaon, Danoli, Mardongri Sateli, Hiranyakeshi-Savantwadi. *Exsiccata*: SMA — 749, 1547, 2444, 2581, 3088.
Note: This species is an addition to Cooke's Flora.

ACANTHACEAE

39. **Nilgirianthus membranaceus** (Talb.) Bremekamp, in Mat. Mon. Strobil. 280, 1944; Santapau, Bot. Mem. Univ. Bombay No. 2, 43, 1951. *Strobilanthes membranaceus* Talbot, Trees and Shrubs of Bombay (ed. 2), 261, 1902; Cooke, 2: 372 (449), 1905. *Figure*: Talbot, Forest Fl. 2: 327, t. 444, 1911.

An undershrub in forest areas.

Flowering: October-December. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 1214.
Note: T. Cooke has included this species on authority of Talbot; Talbot mentions Kanara as the locality. In Blatter Herbarium there are a few herbarium sheets of this species collected from Matheran by N. A. Irani (2748, 2777-8, 2882-4).

LABIATAE

40. **Leucas cephalates** (Roxb. ex Roth), Spr. Syst. 2: 743, 1825; Graham, Cat. 153, 1839; Wight, Icon. t. 337, 1840; Dalz. & Gibs. 211, 1861; FBI 4: 689, 1885; Cooke, 2: 466 (549), 1905. *Phlomis cephalotes* Roxb. Hort. Bengal, 46, 1814 (nom. nud.) ex

Roth. Nov. Pl. Sp. 262, 1821. *Figure*: Wight, l.c.

Rare herb of waste lands.

Flowering: October-December. *Localities*: Charatha, Amboli, Otavane, Chaukul-Savantwadi. *Exsiccata*: SMA — 3197, 4410, 4602.

Note: This species has been reported from Gujarat by Dalzell and Gibson and from Ahmedabad by Law ex Graham.

41. **Plectranthus striatus** Benth. in Wall. Pl. As Rar. 2: 17, 1831 & in DC. Prodr. 12: 56, 1848; FBI 4: 618, 1885; Mukerjee 43, 1940. *P. gerardiana* Benth. in Wall. Pl. As Rar. 2: 17, 1831 & in DC. Prodr. 12: 56, 1848. *P. gerardianus* var. *brachyantha* Hook. f. Fl. Brit. Ind. 4: 618, 1885.

An erect, branched herb. Flowers small, purple-white in terminal, slender panicles.

A rare plant noticed only at one spot along the border of a forest.

Flowering: September-October. *Locality*: Amboli, Hiranyakeshi-Savantwadi. *Exsiccata*: SMA — 3037, 5075.

Note: This species is an addition to Cooke's Flora.

POLYGONACEAE

42. **Polygonum minus** Huds. Fl. Angl. (ed. 1) 148, 1762; FBI 5: 36, 1886; Steward, Polygoneae East Asia 63, 1930. *P. strictum* Allioni, Fl. Pedem. 2: 207, t. 68, f. 2, 1785; Wight, Icon. t. 1800, 1852. *Figures*: Wight, l.c.; Allioni, l.c.

Rare herb of water-logged areas.

Flowering: October-November. *Locality*: Amboli-Hiranyakeshi-Savantwadi. *Exsiccata*: SMA — 3053; BGK — 121594 (BSI).

Note: This is an addition to Cooke's Flora.

PIPERACEAE

43. **Piper longum** Linn. Sp. Pl. 29, 1753; Graham, Cat. 199, 1839; Dalz. & Gibs. suppl. 84, 1861; FBI 5: 83, 1886; Dalgado, 158, 1898; Cooke, 2: 528 (3: 20), 1905. *Chavica roxburghii* Miq. Syst. Pip. 239, 1843-44; Wight, Icon. t. 1928, 1853. *Figure*: Wight, l.c.

Perennial; grows as undergrowth in shade along forest borders. Common in certain localities only.

Flowering: October-December. *Local name*: Pipli. *Localities*: Sherle, Sonurli, Otavane-Savantwadi. *Exsiccata*: SMA — 244, 992-A, 2122, 3000, 3128, 4478, 4608.

Note: T. Cooke, mentioned it as not indigenous in Bombay Presidency. We have seen it growing wild abundantly in forests at certain localities.

LORANTHACEAE

44. **Dendrophthoe memecylifolius** (Wight & Arn.) Danser, in Bull. Jard. Bot. Buitenz. Ser. 3, 10: 291, 1929. *Loranthus memecylifolius* Wight & Arn. Prodr. 383, 1834; FBI 5: 217, 1886.

Stout glabrous parasite. Leaves oblong or elliptic, dark brown. Flowers scarlet, in umbels on short, stout axillary peduncles.

Partial parasite on forest trees. Rare.

Flowering: October-December. *Locality*: Sonurli-Banda-Savantwadi. *Exsiccata*: SMA — 442.

Note: This species is an addition to Cooke's Flora.

45. **Dendrophthoe neelgherrensis** (Wight & Arn.) Van Tiegh, in Bull. Soc. Bot. Fr. 42, 1895. *Loranthus neelgherrensis* Wight & Arn. Prodr. 383, 1834; Wight Icon. t. 1020, 1845; FBI 5: 216, 1886. *Figure*: Wight, l.c.; Bidie, Neilgherry Loranth. Para. Pl. 4 & 5, 1874.

Stout parasite. Leaves orbicular, narrowed into the petiole. Flowers in fasicles on the nodes of the axils, sessile. Corolla lobes reflexed above the middle; anthers long. Fruit oblong.

Rare. Partial parasite noticed only at one place in a forest.

Flowering: October-December. *Localities*: Charatha, Burdi-Savantwadi. *Exsiccata*: SMA-4333.

Note: This species is an addition to Cooke's Flora.

46. **Taxillus tomentosus** (Roth.) Van Tieghen, Bull. Soc. Bot. France, 42: 256, 1895; Johri & Bhatnagar, Bot. Monog. No. 8, Loranthaceae, 13, 1972. Ramamoorthy, in Fl. Hassan Dist. 31, 1976. *Loranthus tomentosus* Roth. Nov. Pl. Sp. Pl. 191, 1821; Talb. List of trees, 171, 1894 (non Heyne 1821).

Large shrub with pendent branches. Leaves ovate-obtuse, rusty-tomentose beneath. Flowers in axillary fascicles of 1-5, tomentose.

In forest areas. Rare.

Flowering: October-March. *Locality*: Mordongri-Savantwadi. *Exsiccata*: SMA — 2456.

Note: This species is an addition to Cooke's Flora.

47. **Drypetes sepiaria** (Wight & Arn.) Pax. & Hoffm. in Engl. Pflanzenf. 81: 271, 1922. *Hemicyclea sepiaria* Wight & Arn. in Edinb. New Phil. Journ. 14: 297, 1833; Wight, Icon. t. 1872, 1852; Dalz. & Gibs. 229, 1861; FBI 5: 337, 1887; Cooke, 2: 590 (3: 87), 1906. *Figures*: Wight, l.c.; Matthew, Fl. Tamil Carn. 2: t. 635, 1982.

Tree of forest areas. Rare.

Fruiting: March-May. *Locality*: Amboli. *Exsiccata*: MRA — 208, 350 (ALC).

Note: This species is included by T. Cooke in 'Bombay Flora' on Talbot's report from North Kanara.

EUPHORBIACEAE

48. **Euphorbia granulata** Forsk. Fl. Aegypt. Arb. 94, 1775; FBI 5: 252, 1887; Cooke, 2: 569 (3: 65), 1906.

Profusely branched, prostrate herb; growing in abundance in rice field after harvest, noticed only at one place.

Flowering: May. *Locality*: Banda, Satarda-Savantwadi. *Exsiccata*: SMA — 4223.

Note: T. Cooke reported this species from Sind.

49. **Glochidion ellipticum** Wight, Icon. 5 (2): 29, t. 1906, 1852; FBI 5: 321, 1887; Cooke, 2: 579 (3: 75), 1906. *Figures*: Wight, l.c.; Matthew, Fl. Tamil Carn. 2: t. 640, 1982.

Common tree of forest areas.

Flowering: December-February. *Localities*: Amboli, Ambegaon-Savantwadi. *Exsiccata*: SMA — 93, 1102, 1482, 2750, 3463.

Note: T. Cooke reported this species from Kanara.

50. **Phyllanthus debilis** Klein, ex Willd. Sp. Pl. 4: 582, 1904; FBI 5: 299, 1887; Cooke, 2: 588 (3: 84), 1906.

Erect herb, woody at base.

Common among grasses and in cultivated lands.

Flowering: September-November. *Localities*: Charatha, Malgaon, Insuli-Savantwadi. *Exsiccata*: SMA — 287, 792, 1372, 1612, 1784, 2192, 3416; MRA — 399 (ALC).

Note: T. Cooke reported this species from Sind.

URTICACEAE

51. **Debregeasia ceylanica** Hook. f. Fl. Brit. Ind. 5: 592, 1885; Gamble, Fl. Madras 2: 1379 (3: 972), 1925.

Tree. Leaves simple, long-petioled, broadly rotund-ovate, round at base, white tomentose beneath, 3-nerved from base. Flowers sessile, unisexual, in axillary, branched, cymose, globose head.

Tree of ghat areas. Rare.

Flowering: September-October. *Locality*: Amboli-Savantwadi. *Exsiccata*: SMA — 1996, 2667.

Note: This species is an addition to Cooke's Flora.

52. **Elatostema sessile** Forst. var. **cuspidata** Wedd. Monogr. 294, 1856; FBI 5: 564, 1888; Gamble, Fl. Madras 3: 963, 1967. *E. cuspidatus* Wight, Icon. t. 1983, 1853. *Figure*: Wight, l.c.

Small herb. Leaves oblanceolate, sessile, membranous, inequilateral, Flowers small, sessile, axillary.

Herb of old walls. Rare.

Flowering: August-October. *Locality*: Aronda-Savantwadi. *Exsiccata*: SMA — 541. *Note*: This species is an addition to Cooke's Flora.

53. **Ficus beddomei** King, Ann. Roy. Bot. Gard. Calcutta, 1: 26, t. 24 & 81, 1887; FBI 5: 502, 1888; Gamble, Fl. Madras, 3: 954, 1956; Corner, Gard. Bull. Straits. Settlm. Ser. 4, 21: 12, 1955; Matthew, Fl. Tamilnadu, Carnatic 3: 1516, 1983. *Figures*: King, l.c.; Matthew, Fl. Tamil Carn. 3(2): 110b, 1983.

Large tree. Leaves ovate-rotund, long-petioled, broad at base, shortly acuminate, 3-nerved. Receptacle in axillary pairs, ovoid.

Tree of ghat areas. Rare.

Flowering: April-May. *Locality*: Ambegaon-Kaleli-Savantwadi. *Exsiccata*: SMA — 2777.

Note: This species is an addition to Cooke's Flora.

54. **Ficus callosa** Willd., in Mem. Acad. Berc. 102, 1798; FBI 5: 576, 1888; King, in Annales Royal Bot. Gard. Calcutta, 1: 64, t. 85, t. 84, f. 4, 1887; Cooke, 2: 651 (3: 152), 1907. Talbot, For. Fl. Bombay Pres. & Sind. 2: 521, 1911. *Figure*: King, l.c.

Fairly common tree of forest areas.

Flowering: May-July. *Localities*: Amboli, Otavane, Danoli-Savantwadi. *Exsiccata*: SMA — 1571, 2174, 4756.

Note: Cooke mentioned Kanara as the locality for this species.

55. **Ficus tjakela** Burm. f. Fl. Ind. 227, 1768; King, Ann. Roy. Bot. Gard. Calcutta, 1: 57, t. 70 & 84, f. x, 1887-88; FBI 5: 514, 1888; Cooke, 2: 650 (3: 150), 1907. *Figure*: King, l.c.

Large deciduous tree of ghat areas.

Flowering: April-May. *Locality*: Bhedsi-Ramghat-Savantwadi. *Exsiccata*: SMA — 2777. *Note*: T. Cooke mentioned N. Kanara, as the locality for this species.

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THE DIET OF THE WHITECHEEKED BULBUL *PYCNONOTUS LEUCOGENYS*[1]

Khalid Y. Al-Dabbagh, Jameel H. Jiad and Intisar N. Waheed[2]

(*With four text-figures*)

The whitecheeked bulbul is a very common bird of date palm-citrus orchards in Iraq, and has often been accused of causing damage to fruits. The bulbul is frugivorous, feeding mainly on ripe fruits and in particular ripe dates (90% of total fruits eaten). It also takes insects, mainly ants and wasps, in proportion related to their availability in the field. In addition, flowers, nectar, and green fresh leaves were also recovered in the food. Damage to fruits could occur only if fruits were left on the trees for longer periods than necessary after ripening or secondarily to damage caused by other animals.

INTRODUCTION

The whitecheeked bulbul *Pycnonotus leucogenys mesopotamia* Ticehurst is one of the most common passerines of date-palm plantations in Iraq. It is particularly common in mixed date palm-citrus orchards where the bulbul benefits from this association by using the first as food and the second for nesting. Furthermore, the bulbul is the only cage-bird from the Iraqi avifauna.

P. l. mesopotamia (Family Pycnonotidae) is rather limited in distribution in the valleys of Tigris and Euphrates rivers in Iraq. It has also been recorded from south Iran and the eastern parts of the Arabian Peninsula (Meinertzhagen 1954, Allouse 1962). The other subspecies *P. leucogenys leucotis* have extended distribution and are found in Afghanistan, Pakistan and Himalayas to E. Assam (Walters 1980). The bird is medium sized (total length *c.* 20 cm) and easily distinguished by the black to immature brown head and the large white patch on each cheek, also by its yellow vent and the white spots on the tip of the tail.

The bulbul has been described by Allouse (1962) as being frugivorous and takes insects only occasionally, a diet resembling that of many other bulbuls of the family Pycnonotidae (Ali 1943, Austin 1961). Consumption of fruits has aroused apprehension as to the role of bulbuls as pests. Meinertzhagen (1954) accused them of causing immense harm to dates in Bahrein; Baker (1922) reported damage to fruits in India; and Ali and Ripley (1971) believe that bulbuls are apt to do some damage in gardens to buds, fruits and vegetables. Similar allegations are often made by Iraqi farmers, but without soundproof. Therefore, the present work was set up to examine in some detail the food of the bulbul and their role in date palm-citrus orchards, and also to evaluate the possibility of their causing damage to various fruits.

METHODS

A total of 395 birds was collected for the period from August, 1983 to August, 1984. Collection was made by mist nets (2.4 × 12 m × 4 shelves, and 36 mm mesh). Four nets were

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set up in line in a carefully chosen area among the citrus. These were operated for an average of 30 h per month. Trapped birds were weighed upon removal from the net, their standard measurements were taken and then carried to the laboratory in sealed polythene bags.

At the laboratory, each bird was eviscerated and its stomach content was emptied into a small petri-dish for examination. It was analysed following different methods depending on their suitability with the type of food material found in the stomach (Hartely 1948, Hyslop 1980). The contribution of major food groupings: animal food, fruits, flowers, leaves to the total food present in the stomach was estimated by point method. A scale of one to ten points was awarded proportional to their estimated contribution to stomach volume. Insects were identified to family level and other animals as far as it was possible. The number of individuals in each category was then counted and their sizes determined. Sizes of fragmented insects were determined by comparison with adult specimens collected from the same habitat. In all cases, the presence of each food item in individual stomach was recorded for the calculation of percentage occurrence.

STUDY SITE AND AVIFAUNA

A part of the vast date-palm-citrus orchards that extend along both sides of River Tigris north of Baghdad was chosen as the study site. The selected site is 40 ha at Al-Huwaish village (45 km northeast of Baghdad). Date palm-citrus orchards are well organized forests, where date-palm trees are planted as cover; under which citrus is usually planted in thick rows along irrigation canals. The main types of citrus are orange; but lemon, sweet lemon, citron, grape, mandarin and bitter lemon are also planted. Other common fruit trees in the order of their importance are: pomegranate, plums, apricot, peach, apple and fig. The orchard floor is covered with annual herbs and other shrubs which are weeded continuously, especially in well managed orchards. In most areas, citrus are planted at a distance leaving an area from the river banks which is usually flooded during winter. The farmers utilize the latter ground for growing vegetables, such as cucumbers, cowpeas and green beans. When not in use it becomes covered with thick growth of poplar, tamarisk and reeds.

The associated avifauna of date palm-citrus orchards is very rich including resident, winter visitors, summer visitors and passage migrants. The most common resident birds next to the bulbul are the house sparrow (*Passer domesticus*), ringed dove (*Sterptopelia decaocto*), magpie (*Pica pica*), wood pigeon (*Columba palumbus*) and babblers (both Iraqi *Turdoides altirostris* and common *T. caudatus*). Wintering birds usually arrive at the site in early October and leave late in May. These include many small passerines, of which the robin (*Erithacus rebecula*) and the willow warbler (*Phylloscopus trochilus*) are the most abundant. Many warblers pass through the site during their spring and autumn migration and become common for short periods. During summer, the rufous warbler (*Erythropygia galactotes*) and the turtle dove (*Streptopelia turtor*) are abundant. They arrive in early May, breed in the area, and leave by late October. Resident birds have different food and feeding habits; similarly, most of the visitors are insectivorous birds. Therefore, little competitive influence is expected from these birds on the bulbul.

The climate of the area is relatively harsh. Temperature is over 40°C for more than four months (June-September). The mean monthly maximum temperature during the period of study varied between 16.0°C in January and 43.9°C in July. The respective mean minimum temperature was 4.4° to 25.2°C during the same months. Together with such high temperatures, rainfall is only limited to December-February, with an average monthly precipitation of less than 25 mm. Relative humidity is consequently low. It varied between 23% in July and 77% in December. Relative humidity was less than 50% for nine months of the year. The climate could, therefore, be summed up as hot and dry for most of the year.

Results

Abundance and general habits:

The bulbul was the most common resident bird in date palm-citrus orchards. Attempts to measure their density were not very successful because of the thick cover of orange trees and the silent escape behaviour of bulbuls when disturbed. However, a "netting index" is presented to reflect monthly changes in relative abundance and pattern of activity changes (Fig. 1). The mean monthly number of birds trapped per ten-hour netting varied with peaks in June and September. The first peak coincided with the completion of the first clutch and the second with that of the second clutch. This was evident from the relatively high proportion of juveniles trapped during these two months.

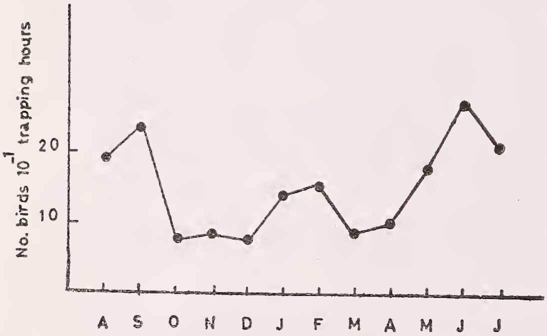

Fig. 1. Monthly changes in the "netting index" of bulbuls trapped during the period of study.

Outside the breeding season, bulbuls usually move about in loose flocks of 5 to 15 birds. Pairs maintain their bond within the flock and throughout the inter-breeding season. At the beginning of March, new pairs were formed and soon flocks were dissolved. Paired bulbuls commence breeding by the beginning of April and continue throughout the summer, with at least two clutches laid per season. Breeding was over by September and flocks reappeared afterwards. Nests were built on the low branches of citrus (1.5-2 m high) and in particular those branches overhanging the irrigation canals. The nest was an untidy open cup, usually made of thin dry twigs and fibres obtained from date-palm trunks. Each nest contained three eggs (range 2-4) which had a pinkish ground colour spotted heavily with dark brown without a noticeable pattern.

Bulbuls actively foraged for most of the day; full stomach (<50% full) was equally distributed among the daily hours of feeding. Also, no seasonal variations were noticed in feeding activity or time of food collection. The food was gathered at almost all possible places, ranging from date-palm tops, (about 10 m) to feeding on the ground. Several techniques were used for food gathering and handling, depending on type of food. Most fruits were picked up from trees, and sometimes from those fallen on the ground. Insects were collected from among foliage, tree trunks, ground fruits (infested with insect pests) and from the air. Aerial feeding seems to be a common practice in bulbuls (Severinghaus 1978); and has been reported for *P. l. mesopotamia* by Meriwani (1973).

The food of the bulbul:

The bulbul was basically frugivorous, feeding on a wide range of available ripe fruits in their habitats. Flowers and leaves were also taken in relatively smaller quantities (Table 1). Animal food was also common and included mainly different types of relatively small insects (Table 1).

Among fruits, ripe dates were the most desired (90% of total fruit consumed). These were available for long periods from late August to March or April. Some varieties were more readily consumed than others. Other fruits were also taken, some with noticeable preference. These, according to the degree of preference were: figs, mulberries, peaches, pomegranate, apple, pear, grapes and plums. The appetite for figs and mulberries was so strong that bulbuls usually congregated on these trees for feeding when fruits were ripe. However, these fruits remain unimportant in terms of their total contribution to the bulbuls' diet because of the short period when they were actually available.

Table 1

A list of *Pycnonotus leucogenys* diet and the relative importance of the food items

FRUITS	
Dates (*Phoenix dactylifera*)	++
Fig (*Ficus carica*)	+
Mulberry (*Morus nigra*)	+
Pomegranate (*Punica* sp.)	+
Peach (*Amygdalis persica*)	+
Plums (*Prunus* sp.)	(+)
Apricot (*Armeniaca* sp.)	(+)
Apple (*Malus communis*)	(+)
Grape (*Vitis* sp.)	(+)
FLOWERS	
Vegetables:	
Okra, Cucumbers, Cowpeas	+
Orange flower & Nectar	(+)
Fruit tree flowers	(+)
LEAVES	
Vegetable fresh leaves	+
Leaf buds	(+)
ANIMAL FOOD	
Coleoptera	
Nitidulidae	++
Chrysomelidae	+
Teneberionidae	+
Alleculidae	(+)
Bruchidae	(+)
Apionidae	(+)
Coccinellidae	(+)
Scarabidae	(+)
Staphilinidae	(+)
Unidentified	+
Hymenoptera	
Formicidae	++
Vespidae	++
Brachionidae	+
Scoliidae	(+)
Evanidae	(+)
Andrenidae	(+)
Ichnaeionidae	(+)
Halcitidae	(+)
Megachilidae	(+)
Hemiptera	
Pentatomidae	+
Coreidae	+
Lygaeidae	(+)
Tingidae	(+)
Orthoptera	
Acrididae	+
Gryllidae	(+)
Gryllotalpidae	(+)
Homoptera	
Aphididae	+
Neuroptera	
Crysopidae	(+)
Diptera	
Culicidae	(+)
Syrphidae	(+)
Arachnida	+
Mollusca	(+)

++ common, < 15% occurrence; + present in moderate numbers mostly > 10% occurrence, (+) rare, present in > 5 individuals

Several types of flowers were consumed, most important of which were vegetable flowers (Table 1), available mainly during summer. Citrus flowers were also taken during the short period of blooming during early March. The nectar from date-palm male flowers (spadix), available during late March and early April was taken with noticeable greed. Trapped bulbuls had their bills tinted with yellow at this time of the year, owing to the coating by pollen from the spadix. However, nectar from the large flowers of some vegetables could also produce a similar effect. Plant leaves, usually leaf buds, were less common in the food and were mainly from vegetables.

Animal food was mainly insects (Table 1), and occasionally some arachnids (Lycosid spiders) and molluscs were recorded in the diet. The distribution of insect orders, both as percentage occurrence and percentage of total number of insects present in the food is shown in Fig. 2. The figure demonstrates clearly that Coleoptera and Hymenoptera were equally important, and constituted the major bulk of insect food. Hemiptera was next in importance with moderate number of insects in the diet. Other insects were less common and their percentage occurrence or their numbers did not exceed 5% of total food examined. The number of homopterans (Aphids) was an exception because of the large number of these tiny insects recovered from several bulbuls. Among Coleoptera, the Nitidulidae (mainly *Carbophilus* sp.) were the most common. These beetles usually infest ripe fruits and were collected directly from them by the bulbuls. Ants (Formicidae) and wasps (Vespidae) were the most common among Hymenoptera; the former were collected mainly from the ground, while the latter were caught on the wing (aerial feeding).

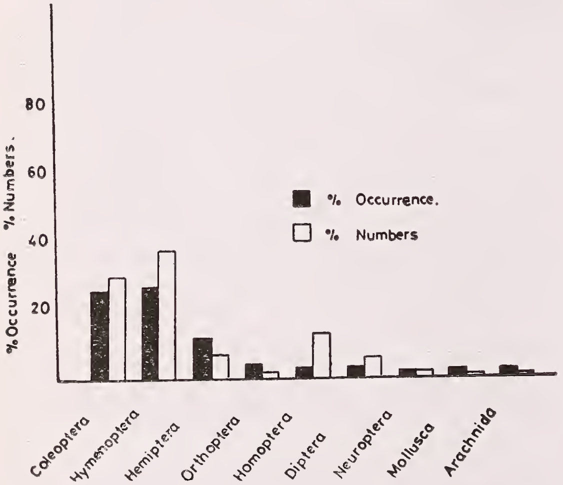

Fig. 2. Percentage occurrence and percentage of numbers of animal material in the diet of the bulbul. Solid bars; % occurrence, clear bars; % numbers.

The sizes of insects taken by bulbuls varied between 2-20 mm in length. Parts of larger insects (*c.* 40 mm), were occasionally observed. Frequency distribution of the size of insect (Fig. 3) was skewed towards the smaller ones.

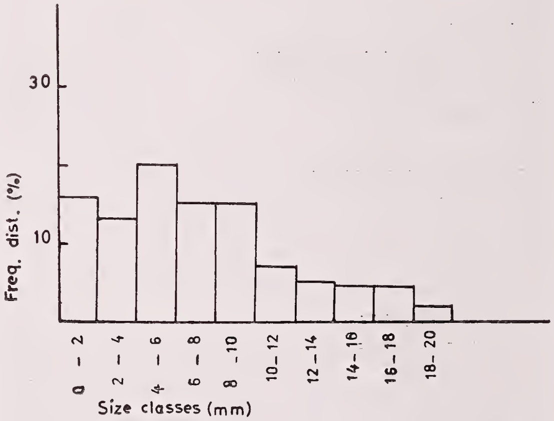

Fig. 3. Frequency distribution of insect sizes taken by the bulbul in the diet.

This was due to the relatively large numbers of small-sized nitidulid beetles and aphids found among the food of the bulbul.

Seasonal changes in the diet:

The monthly changes in the main food items — animal food, fruits, flowers and leaves are presented in Fig. 4, both as percentage occurrence and percentage contribution by volume of these food items to the stomach content (points method). The figure shows that fruits dominated the food for most of the year, and were particularly important during winter (December-March). The high percentage occurrence of fruits during several months was mainly due to the regular occurrence of dates in the food, while those of April and May were due to the presence of the seasonal fruits. Animal food varied among months depending probably on their availability. Therefore, more animal food was recorded during summer (April-November). Flowers were less important and varied widely among the months. However, two distinct peaks in flower consumption coincided with peak flowering seasons i.e. March for the spring blooming trees and September for vegetable species. Fresh leaves were taken irregularly without a clear pattern, and were not recorded in the diet for several months.

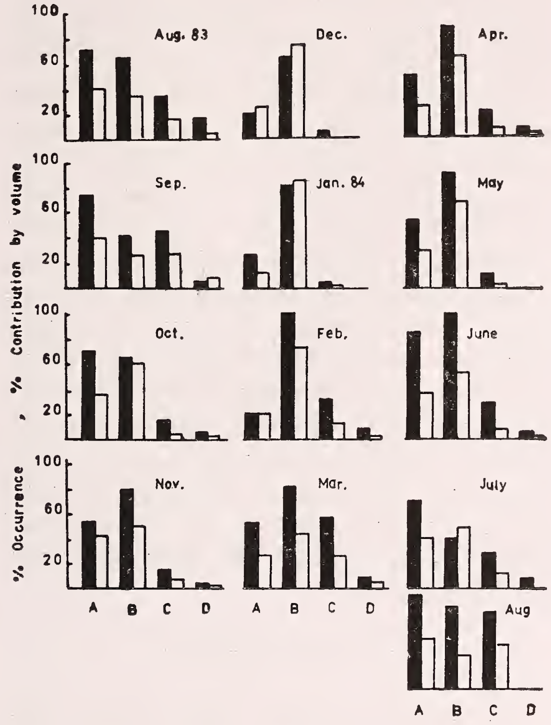

Fig. 4. Mean monthly changes in percentage occurrence and percentage contribution by volume of the main food items in the stomach of the bulbul. Solid bars; % occurrence, clear bars; % contribution by volume. A, animal food, B, fruits, C, flowers, D, leaves.

DISCUSSION

Whitecheeked bulbul is mainly frugivorous, but supplements its diet with insects. Similar type of food has been described for *P. leucogenys* from India and Pakistan (Ali & Ripley 1971, Walters 1980). Other species of bulbuls have also been reported to feed on ripe fruits and insects. Ward (1969) described the food of *Pycnonotus goiavier* as being mainly ripe fruits and large insects including grasshoppers, mantises, beetles, moths and caterpillars; while Carleton & Owre (1975) showed that *Pycnonotus jocosus* consumes seedlings, growing shoots, flower parts and nectar in addition to fruits and insects as their main food. It seems frugivory is a main characteristic of the members of Pycnonotidae (Baker 1922, Austin 1961, Ali & Ripley 1971, Walters 1980).

P. l. mesopotamia consumed ripe fruits throughout the year, with very little seasonal variations. Dates were the main fruit and persisted in the diet for long periods starting from August (new crop) extending to March. This was mainly due to the system of management in date palm-citrus orchards, where management is concentrated on citrus crops while date-palms were only utilized as cover, and their fruits were usually left on the trees untouched. In similar orchards, where dates were properly cropped at season, a large quantity of dates scattered on the ground were left uncleaned, which in turn provide enough food for bulbuls over the winter. At the time when dates become short in supply, or their quality deteriorate, bulbuls shift their preference to other ripe fruits now available in their habitat, such as pomegranate, figs and peaches. This would last for a few months from the end of April to August, until the new crop of dates becomes available. In addition, more flowers, nectar and leaf buds become evident in the food and in particular, at times when the above two food items were not readily available (March and August). Insect food showed a well pronounced pattern of seasonal variation depending on their availability, and this variation was irrespective of that of plant food.

Despite the fact that bulbuls feed mainly on fruits, claims of damage were not entirely justified. Damage could occur during years of low production or when fruits are left on the trees for longer period than necessary after they are ripe. It is true that some fruits are more readily attacked than others. However, proper cropping at the time of ripening reduces damage to the minimum. This has been observed in some good quality dates, where a slight delay in harvesting the fruits led to immense damage. The abundance of this variety, however, is small compared to the common type used for cover.

Damage to orange and other citrus was negligible, and occurred only secondarily after other animals made the initial attempt on the fruits. The black rat *Rattus rattus* has been shown to cause such damage in date palm-citrus orchards (Khadim *et al.* 1984). The pomegranate suffer similar damage, and these, together with other fruits like peaches, attract bulbuls when heavily infested with insects (mostly Nitidulid beetles). A closely similar situation was reported by Carleton & Owre (1975) for the red whiskered bulbul in Florida.

Date palm-citrus orchards seem to be a highly suitable habitat that attracts a good number of bulbuls. The continuous availability of dates as food has probably diverted bulbuls from consuming other fruits and consequently reducing damage to those more wanted fruits by farmers. This could be ascertained by studying any of the single-fruit type orchards and comparing the findings with those of the present investigation.

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A PRELIMINARY REPORT OF THE INCIDENTAL ENTRAPMENT OF ODONTOCETES BY SRI LANKA'S COASTAL DRIFT NET FISHERY[1]

ABIGAIL ALLING[2]

(*With four text-figures*)

Odontocetes are taken by both direct and indirect fisheries off the coast of Sri Lanka. An estimated 38,000 odontocetes are entangled annually in gillnets deployed within 30 miles (48 km) of the shoreline from 26-60′ vessels. The two species most frequently taken are spinner, *Stenella longirostris,* and Risso's dolphins, *Grampus griseus.* Ten species of cetaceans were seen in fish-markets by the author in the relative frequencies: spinner dolphin (40%), Risso's dolphin (17%), spotted dolphin, *Stenella* cf. *Stenella attenuata* (13%), striped dolphin, *Stenella coeruleoalba* (8%), bottlenose dolphin, *Tursiops* sp. (7%), Pygmy killer whale, *Feresa attenuata* (4%), dwarf sperm whale, *Kogia simus* (4%), rough-toothed dolphin, *Steno bredadensis* (4%), false killer whale, *Pseudorca crassidens* (1%), Cuvier's beaked whale, *Ziphius cavirostris* (1%), and an unidentified beaked whale (1%). Since the incidental entrapment of cetaceans is a worldwide problem which may be assuming crisis proportions, this report will have application to any fishery which presently catches small odontocetes in gillnets.

Gillnets have been used by fishermen for centuries, but it has not been until the last thirty years that the incidental entrapment and entanglement of cetaceans in tended and untended nets has been extensive enough to be of serious concern (Coleman & Wehle 1983, Wallace 1984). Gear modification, technical advances, and an increase in the number of boats harvesting fish have been primary causes of such mortality (Curry-Lindahl 1982). In particular, the replacement of cotton nets with synthetic nets in the 1950's marked the beginning of an increased take of both target, commercial fish, and non-target marine animals, cetaceans, birds, turtles, etc. (Wallace 1984).

Synthetic nets are composed of plastic webbing which is visually and acoustically invisible to marine mammals (Gaskin 1984). The nets, which are suspended in water by floats and stretched vertically by weights attached to their bottom, hang in the water like "Curtains of Death" (Eisenbud 1984). Not only are the nets undetectable to cetaceans, but the plastic, synthetic fibres are unbreakable, which prevents animals from escaping once caught. Any fishery which utilizes gillnets in the same habitat as cetaceans has the potential to catch these animals that swim blindly into the net and become entangled. Incidental entanglement of cetaceans in gillnet fisheries is now recognized as a world-wide problem, but there is little information about the impact of such fisheries on specific populations.

Preliminary investigations about the location and status of direct and indirect cetacean fisheries indicate that odontocetes are being taken throughout the world, but the number of animals killed is largely unknown (Brownell *et al.* 1978, Mitchell 1975). In addition, the behaviour, ecology, and biology of many of

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the species involved has not been studied, so it remains unclear whether or not whole populations or even species may be endangered. Detailed information about cetacean entrapment in pelagic fishing gear has been documented in purse seine fisheries (Perrin & Oliver 1982, Allen & Goldsmith 1982, Hammond & Tsai 1983) and in pelagic fisheries (Jones 1984, Harwood *et al.* 1984, Kumagai *et al.* 1983, Lear & Christensen 1975, Oshumi 1975). However, there is little information about land based, coastal drift net fisheries and their impact on odontocetes (Alling & Whitehead 1986, Leatherwood 1984, Lien *et al.* 1982). This paper describes the incidental entrapment of odontocetes by coastal drift net fisheries off the coast of Sri Lanka. As there are no existing legislative, administrative, biological or technical means to prevent the incidental mortality of cetaceans by drift net fisheries (Holt 1983), it is hoped that this study will provide a framework for which such problems can be addressed.

Types of marine fisheries in Sri Lanka

Sivasubramaniam (1965) categorized the Sri Lankan fisheries into non-mechanized, traditional-mechanized, modern-mechanized and trawling operations. As described by Pajot (1978), non-mechanized vessels (outriggers or canoes) are used by fishermen who work within 1-2 miles of the coast, casting "Beach Seines" on schools of pelagic fish species. This method is restricted to calm waters and, in general, it is only effective for half the year on each coast due to the monsoons. Traditional-mechanized craft consist of Orus, Vallams, or Teppams (vessels with outboard motors) and modern mechanized craft, which are larger, 26-60′ ($3\frac{1}{2}$-$17\frac{1}{2}$ ton) vessels (Sivasubramaniam 1965). These boats harvest pelagic species by using "Pole and Line" techniques, longlines, or gillnets which are set at night as drift nets. Long lines are used for large pelagic species (tuna, shark, spearfish, etc), "pole and line" for the smaller species (tuna and mackerel), and drift nets for both types (Pajot 1978).

The boats using drift nets embark for sea usually in the mid-afternoon. Fishermen motor up to 30 miles (48 km) offshore (usually about 20 miles, i.e. 32 km) where they set their nets until dawn. The duration of time the nets are set depends on the cycle of the moon. During the full moon, for example, nets are used for only a few hours when the night is at its darkest period. (The fishermen claim that fish can "see" the nets unless there is no sun or moonlight). Fishermen also cannot set gillnets during the southwest monsoons (summer) along the east coast, or during the Northeast Monsoons (winter) off the west coast because the seas are too rough. Therefore, they either change gear to work inshore (e.g. fishermen in Trincomalee harvest spawning flying fish during May to August), or they continually move along the coast to avoid the bad weather in order to use their gillnets throughout the year.

Trawlers are used exclusively for deep-sea fisheries. Traditionally, the Government of Sri Lanka operated trawlers on the Wadge and Pedro banks, but by 1964 all the vessels were transferred to the Ceylon Seafoods Corporation, a private enterprise. Now the Law of the Sea gives India rights of resources on or near Wadge Bank which has forced this Company to extend its operations to other pelagic regions (Piertersz 1965). According to the Manager of Ceylon Seafoods in Trincomalee, the vessels remain at sea for two days to two weeks while working approximately 50 miles (80 km) offshore. The fishermen set drift nets at night and they trawl during the day for Tuna, Seerfish, Shark or Marlin.

Department of Fisheries found that there was an annual increase of 6,000 tons of fish harvested (Weerakoon 1963). He attributed this increase to the introduction of mechanized vessels and synthetic gillnets. By 1958 he estimated that almost all the fishermen had switched from using cotton nets to multifilament, nylon gear varying in color (yellow, grey, green, or white), in twine size (21, 24, 27 and 30 ply), in mesh size (4, 5.5, 5.75, 6 and 7 inch) and in overall size (500 to 1,000 by 50 to 150 meshes). These gillnets are used by fishermen who operate the 3½ and 17½-ton vessels or trawlers. In 1982, there were 8,850 3½ and 17½-ton vessels registered in Sri Lanka. (This statistic has not been updated by the Sri Lanka Department of Fisheries). This paper reports on the number of odontocetes taken incidentally by gillnets deployed from these boats.

Past and present commercial utilization of small cetaceans

A dolphin fishery was first reported in Sri Lanka in the late 1800's (Necill 1887). He reported that one species, no larger than 1.7 m and characterized as a fierce animal, was speared and eaten by fishermen. A second species, which Necill called *Delphinus,* was found close to shore and in the lagoons of Kalputti and Trincomalee. Revered as a sacred animal, this species was not killed by the resident Tamil or Sinhalese people, but Indian fishermen specifically hunted and captured these dolphins in nets for food.

In 1953 and 1954, the Sri Lanka Department of Fisheries and the Canadian Government explored the possibility of commercially exploiting dolphins (Lantz & Gunasekera 1955). They identified the Cetaceans as common dolphins (*Delphinus* sp.) and bottlenose dolphins (*Tursiops truncatus*). (However, a photograph included in the article showed a striped dolphin suspended over the deck of the vessel). They noted that fishermen, who were working out of Trincomalee and Negombo harbours, complained of excessive net damage which sometimes forced them to abandon their gillnet fisheries in January and February. It was assumed that this destruction was caused by dolphins. In response to this problem and concern that these animals competed with fishermen for limited food resources, methods were devised to capture and utilize dolphins. The meat was used for human consumption, the Sri Lankan Department of Industries produced two kinds of leather from the skins, oil was prepared as a lubricant, and waste materials were processed into meal. They concluded that commercial utilization of dolphins in Sri Lanka would not only be possible, but beneficial to the fishermen.

At present, the degree to which cetaceans are hunted off Sri Lanka is in question. Mitchell (1975) and Brownell, Schonewald, & Reeves (1978) acknowledged the existence of a dolphin fishery, but urged that more information be obtained. Beginning in 1982, efforts were made to monitor the take of dolphins in several harbours along the coast of Sri Lanka (Alling 1983, Joseph *et al.* 1983). These studies suggested that dolphins may be hunted by some fishermen, but most of the animals are entangled incidentally in gillnets. Similar findings have been recently reported by others as well (Leatherwood 1984, Leatherwood *et al.* 1984) and in 1985 the National Aquatic Resources Agency (a Department within the Sri Lankan Ministry of Fisheries) established a research programme to thoroughly review this fishery. In general, it appears that dolphin meat may be sold for human consumption or for shark bait. Frequently, however, the meat is sold to a buyer who exports it inland or to Colombo (the capital) where it may be sold as

"Mudu-uru". Mudu-uru, known as "sea pig" or dugong, is considered a delicacy and is purchased by those who cannot afford the more expensive fish, by Catholics or Muslims (not Buddhists or Hindus because it is against their religion to eat dark meat), or by people who live inland.

METHODS

A study of this cetacean fishery was carried out in Sri Lanka from March, 1982 to December, 1984. The scope of the project was significantly narrowed because it was conducted in conjunction with an oceanic study of the behaviour and ecology of sperm whales, *Physeter macrocephalus.* However, incidental sightings of cetaceans were recorded while at sea and, when time permitted, harbours were visited to identify odontocetes that were brought into fish-markets, fishermen were interviewed to enquire about direct and indirect cetacean fisheries, and a system was established to monitor the daily take of odontocetes brought into three harbours. In this paper, "odontocetes" refers to all the toothed species found in Sri Lankan waters except for the sperm whale.

The offshore study was conducted from a 9 m sailing vessel, R/V *Tulip,* during the spring (January to May) of 1982-1984. All cetaceans sighted off the coast of Sri Lanka were recorded and their positions are shown in Fig. 1. Since our primary objective during this time was to track and follow sperm or blue whales (*Balaenoptera musculus*), all sightings of other cetaceans are biased to preferred blue and sperm whale habits.

When we were not working at sea, I visited ten fishing harbours in Sri Lanka, which are illustrated in Fig. 1. Equal time was not alloted to each of these harbours because I worked primarily in Beruwala (on the west coast) and Trincomalee (on the east coast). Dolphins brought into each harbour were identified and, when time permitted I measured, determined the sex of, and photographed animals using a standard morphometric form (Norris 1961). Skulls were collected when possible and sent to the Smithsonian Institute. Not all the animals were measured because the fishermen often immediately used the dolphin meat for food or bait. Thus, of the 72 cetaceans seen, 39 animals were measured, 31 were distinguished as "calves" (13 of these animals were recorded as calves and were measured) and 13 observations had missing data. Assessing if an animal was a "calf" could not be quantified, but it is justified because a superficial look at the size of an individual indicated if it was about half the size of a full grown animal.

The daily catch of cetaceans brought into fishmarkets was monitored in Beruwala (May, 1982-August, 1984), Trincomalee (February, 1983-October, 1984) and Valaichenai (March, 1983-January, 1984). One fisherman in each of the three harbours agreed to record the number of odontocetes which were entangled in gillnets and brought into his habour each day. This information was returned to me at the end of each month so as to obtain an estimate of the number of odontocetes taken annually off the coast of Sri Lanka. In this exercise, only a rough calculation could be made due to the following assumptions:

1. The average number of odontocetes taken by 397 3½ and 17½-ton vessels in three harbours reflects the average number of odontocetes taken by all 8,850 registered 3½ and 17½-ton vessels in Sri Lanka. Variability in season or location does not affect the average rate.
2. Only the registered 3½ and 17½-ton vessels set gillnets which entangle cetaceans.
3. Differences in mesh size, twine size, colour,

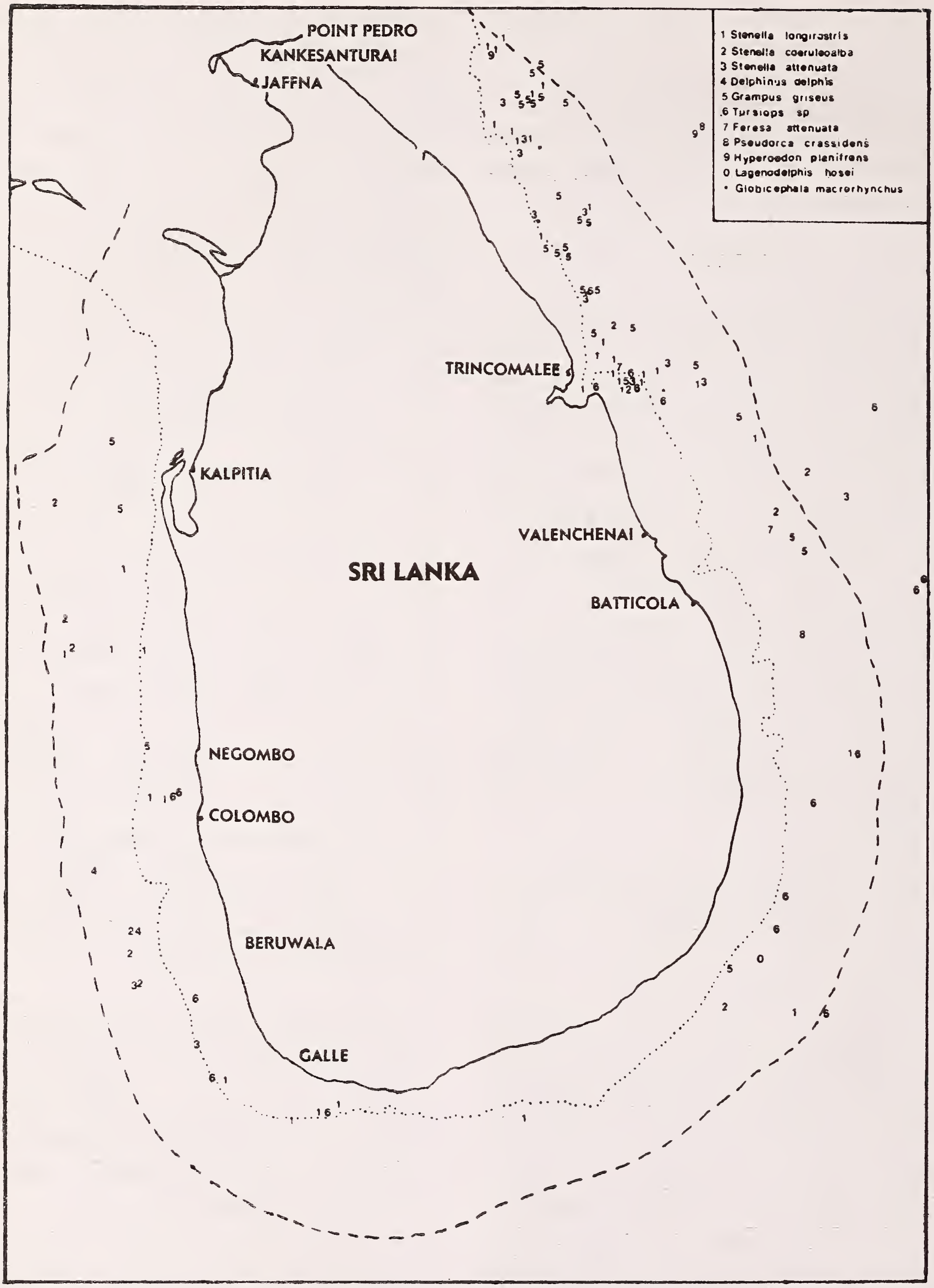
POINT PEDRO
KANKESANTURAI
JAFFNA
TRINCOMALEE
KALPITIA
VALENCHENAI
SRI LANKA
BATTICOLA
NEGOMBO
COLOMBO
BERUWALA
GALLE
1 Stenella longirostris
2 Stenella coeruleoalba
3 Stenella attenuata
4 Delphinus delphis
5 Grampus griseus
6 Tursiops sp
7 Feresa attenuata
8 Pseudorca crassidens
9 Hyperoodon planifrons
0 Lagenodelphis hosei
• Globicephala macrorhynchus

Fig. 1. Positions of odontocetes sighted from R/V Tulip 1982-1984. The slashed line is drawn 30 miles from the coast to represent the maximum distance fishermen will motor to set drift nets. The dotted line is a 1,000 m contour line. Harbours around the coast of Sri Lanka which were visited to determine if odontocetes were being taken by fishermen along the north, south, east, and west coasts.

and overall size of gillnets used by fishermen does not influence the rate of take.

To obtain an estimate of the number of animals which may be killed annually by vessels operating out of all the harbours in Sri Lanka, I used the equation:

N = R × B × 12 months, where
N = the total estimated number of odontocetes killed annually in Sri Lanka,
R = the rate (average number of dolphins taken by $3\frac{1}{2}$ and $17\frac{1}{2}$-ton vessels per month in Beruwala, Trincomalee, and Valaichenai), and
B = The number of registered $3\frac{1}{2}$ and $17\frac{1}{2}$-ton vessels in Sri Lanka.

RESULTS AND DISCUSSION

1.— *Incidental take of small cetaceans by traditional and modern mechanized vessels.*

While working in fishing harbours for two days in 1982, 48 days in 1983 and 18 days in 1984, I saw 72 odontocetes brought into fish markets. Of these animals, all were identified, 52 were measured, sexed, or photographed, and six skulls were collected and sent to the Smithsonian Institution. The ten different species which I identified (Table 1) were spinner dolphin, *Stenella longirostris* (40%), Risso's Dolphin, *Grampus griseus* (17%), spotted dolphin, *Stenella* cf. *Stenella attenuata* (13%), striped dolphin, *Stenella coeruleoalba* (8%), bottlenose dolphin, *Tursiops* sp. (7%), pygmy killer whale, *Feresa attenuata* (4%), dwarf sperm whale, *Kogia simus* (4%), rough-toothed dolphin, *Steno bredadensis* (4%), false killer whale, *Pseudorca crassidens* (1%), Cuvier's beaked whale, *Ziphius cavirostris* (1%), and an unidentified beaked whale (1%). It appears that *Kogia brevicauda,* pygmy sperm whale (Leatherwood 1984), and *Orcaella brevirostris,* Irrawaddy dolphin, may also be taken incidentally in gillnets (Joseph *et al.* 1983).

TABLE 1
THE RELATIVE FREQUENCIES OF ODONTOCETES OBSERVED IN SRI LANKAN FISH MARKETS IN 1982, 1983 AND 1984

Species	Frequency of observations %
Stenella longirostris	40
Grampus griseus	17
Stenella cf. *Stenella attenuata*	13
Stenella coeruleoalba	8
Tursiops spp.	7
Feresa attenuata	4
Kogia simus	4
Steno bredadensis	4
Pseudorca crassidens	1
Ziphius cavirostris	1

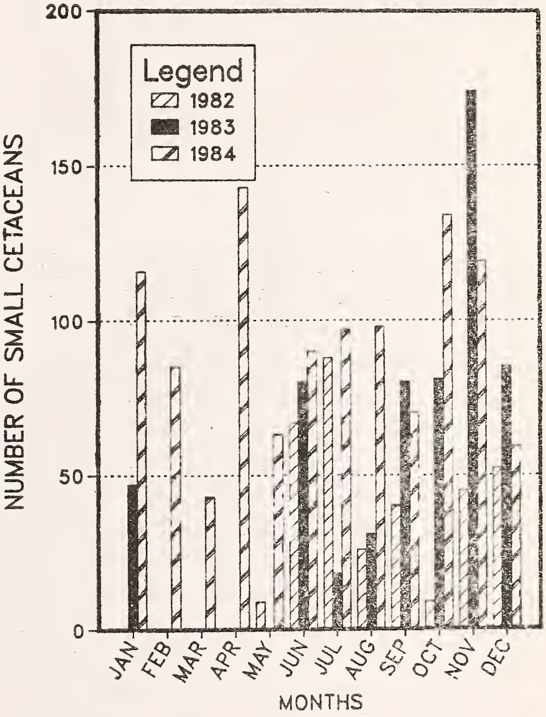

Fig. 2. The number of small cetaceans entangled in gillnets and brought into Beruwala Harbour, May 1982-December 1984.

Beruwala was monitored for 28 months (1982-1984), Trincomalee for 23 consecutive

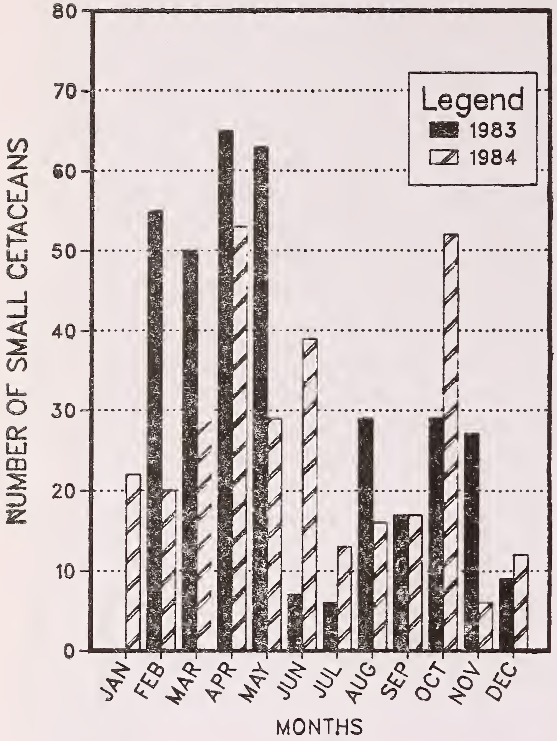

Fig. 3. The number of small cetaceans entangled in gillnets and brought into Trincomalee Harbour, February 1983-December 1984.

months (1983-1984), and Valaichenai for 11 consecutive months (1973-1984). The number of odontocetes taken each month in these three harbours is illustrated in Figs. 2, 3, & 4. Of the harbours I visited around the island (Fig. 1), fishermen in each harbour take odontocetes accidentally in gillnets. It appears, then, that the incidental catch of cetaceans occurs along the entire coast of Sri Lanka and is not a problem only on the east and west coasts.

Thus, these data suggest that 38,000 dolphins could be killed by the $3\frac{1}{2}$ & $17\frac{1}{2}$-ton vessels operating off the coast of Sri Lanka each year. This estimate, however, must be recognized as a necessary, but preliminary, step in assessing the impact gillnet fisheries has on odontocete mortality in Sri Lanka.

The catch of odontocetes appears to be seasonal, increasing during the spring and fall and decreasing slightly during the winter and summer. This fluctuation is probably a result of the monsoon winds. Between the northeast and southwest monsoon seasons, the seas are calm and fishing effort increases. It would be expected, then, that the number of cetaceans entangled in nets would increase when more boats are fishing offshore during the months of March, April, May, October, and November. In general, Figs. 2, 3 & 4 show a slight increase in the number of animals taken during these inter-monsoon periods.

The average number of odontocetes taken per month for each harbour and for each boat

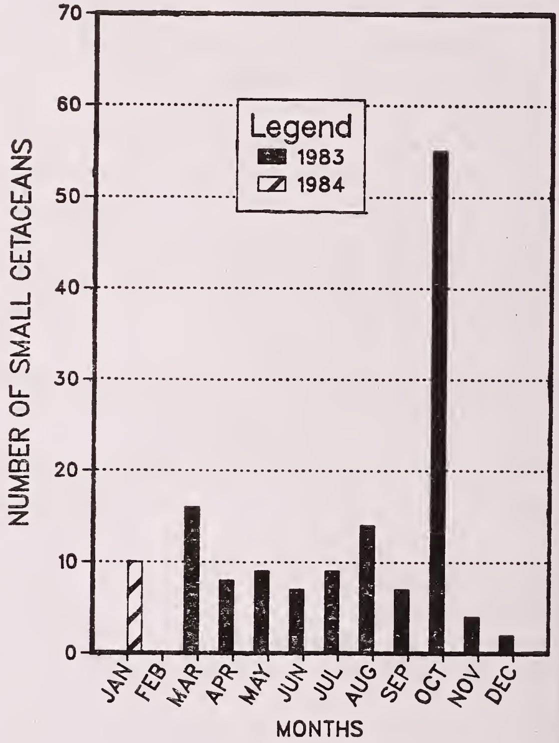

Fig. 4. The number of small cetaceans entangled in gillnets and brought into Valaichenai Harbour, March 1983-January 1984.

is listed in Table 2. Valaichenai and Trincomalee (two harbours on the east coast) take an average of 0.156 dolphins per boat each month whereas Beruwala (a harbour on the west coast) takes an average of 0.559 dolphins per boat each month. Trincomalee, the largest harbour in Sri Lanka, may have been one of the first areas to provide fishermen with synthetic gillnets. It is possible that there are fewer odontocetes on the east coast because populations have been subjected to incidental exploitation for a longer period of time. Alternatively, the difference in the number of animals taken in each harbour may simply reflect the ecology of the area or the types of gear used (e.g. Beruwala fishermen may be using nets that are newer and hence more effective).

TABLE 2

THE NUMBER OF ODONTOCETES THAT WERE BROUGHT INTO FISHMARKETS WAS MONITORED IN BERUWALA, TRINCOMALEE AND VALAICHENAI DURING 1982, 1983AND 1984. THIS TABLE LISTS THE NUMBER OF REGISTERED 3½ AND 17½-TON VESSELS, THE NUMBER OF ODONTOCETES TAKEN PER MONTH PER HARBOUR AND PER MONTH PER BOAT FOR EACH OF THE THREE HARBOURS

	Average # dolphins taken per month per harbour			Average # dolphins taken per month per boat			Number of 3½ and 17½-ton vessels
Harbours	1982	1983	1984	1982	1983	1984	1981
Beruwala	42	74.5	93.1	0.336	0.596	0.745	125
Trincomalee	—	32.5	25.8	—	0.163	0.129	200
Valaichenai	—	12.8	—	—	0.178	—	72

2. *Offshore sightings.*

While working off the coast of Sri Lanka (1982-1984), the crew of R/V *Tulip* recorded sightings of cetaceans. The frequency that these different species were seen at sea is listed in Table 3 and the position of each sighting is illustrated in Fig. 1. The slashed line in this figure is drawn 30 miles (48 km) from the coast to indicate the maximum distance fishermen will motor offshore to set drift nets from the 3½ and 17½ ton vessels. Spinner (34%) and Risso's (23%) dolphins were the most abundant species seen within 30 miles (48 km) of Sri Lanka's coastline.

Overall, there appeared to be a correlation between the frequency that a species was seen in a fishmarket and its relative abundance in coastal waters where nets are set. Points of difference could be largely due to a bias in sampling techniques (e.g., there was no stan-

TABLE 3

THE RELATIVE FREQUENCY WITH WHICH EACH SPECIES WAS SEEN OFF THE COAST OF SRI LANKA, JANUARY THROUGH MAY (1982-1984). THE TOTAL NUMBER OF SIGHTINGS WAS 126

Species	February, 1982-May, 1984 (%)
Spinner dolphin	34%
Risso's Dolphin	23%
Bottlenose Dolphin	14%
Spotted Dolphin	9%
Striped Dolphin	9%
Common Dolphin	2%
Pygmy Killer Whale	2%
False Killer Whale	2%
Pilot Whale	2%
Southern bottlenose whale	2%
Fraser's dolphin	1%

dard offshore survey conducted to obtain information about the distribution and abundance of cetaceans, and observations of odontocetes brought into the fishmarkets were made almost entirely in only one harbour, Trincomalee). In addition, the ability to detect animals at sea may vary between species, and behavioural or physiological traits may also affect the likelihood that a species will become entangled in a net. For example, Pilleri, Gihr & Kraus (1981) suggested that the directivity of the frontal sector of a dolphin's sonar field is different for each species which may enable some species to detect nets more easily than others. Pryor & Norris (1978) contend that some *Stenella* species are particularly 'high-strung, active, and nervous' and in comparison with other cetacean species (in particular the bottlenose dolphin) they are 'behaviourally maladaptive to obstacles'.

The frequency that calves were seen out of a total of 57 animals is listed in Table 4. The high percentage of spinner (52%), Risso's (100%), and spotted (75%) dolphin calves that are taken may be of grave concern. Such high infant mortality could depress the recruitment rate which would be of serious concern for populations that are already depleted. Reasons for a high calf mortality are not known, and may simply be dependent upon the fact that fishing effort increases during the inter-monsoonal periods which may coincide with peak calving periods. For example, if the spinner and spotted dolphins off the coast of Sri Lanka have similar fall and spring calving peaks as Pacific populations (Norris & Dohl 1980, Perrin 1976), then these peaks would coincide with the calm, inter-monsoonal seasons (February-March and September-November). It would be expected, then, that a large percent of calves would be caught, especially if a period of growth is needed before a calf develops physiological mechanisms to avoid nets or learns to adapt behaviourally as shown to occur with Pacific spinner and spotted dolphins in purse-seine nets (Pryor & Kang 1978).

On the other hand, complex social structures within herds may affect the probability that a particular age class will be taken. Pryor & Kang (1978) found that individual aggregations of spinner and spotted dolphins were not disrupted when the animals were entrapped by purse-seine nets and that large aggregations were often composed of groups of animals stratified by age. Their findings are interesting because observations #5, 7, and 8 (appendix 1) are all of calves taken in a single net without adults being entangled as well. As a corollary to this, 8 large spotted dolphins were taken in one net (#9) without the presence of a single calf. Are these observations completely random, or are they indicative of some social structure within a group? It is also curious that spotted and spinner dolphin calves were found in a single net (#7) as well as Risso's dolphins and pygmy killer whales (#4). If the different species were not schooling together, one would expect that the presence of a dead animal in a net would deter a herd of cetaceans from approaching, or at least alert them to danger. Will the entrapment of one animal, then, increase the chance that others will be atracted to it consequently, causing them to be caught? Such observations are curious, but at present it is not known what effect the behaviour, herd structure, distribution, and feeding ecology may have on odontocete entrapment in gillnets.

3. *Incidental catch by non-mechanized vessels.*

There is an incidental catch of odontocetes by the traditional, non-mechanized vessels, but I was unable to determine its extent. Once while walking along a beach in Trincomalee at dusk, I saw three severed dolphin heads near two beached canoes. Although I am not positive that these particular animals were brought onto shore by fishermen who use these boats, I was told by fishermen that men working from traditional vessels do catch dolphins in nets.

4. *Incidental catch by trawlers.*

The managers of the Trincomalee and Kalpitiya Ceylon Seafoods Corporation did not know how many dolphins were caught a year by their fishermen, because the dolphins are seldom brought back to shore. A dolphin that is entangled in a net which is deployed from a trawler at night, will be used the next day for long line bait or it will be discarded because the storage space is needed for the harvest of commercial fish. Each manager estimated that a total of 200 or more dolphins are taken while the vessels are working in their respective harbours. Trincomalee has 5-6 trawlers working offshore during a 4-5 month period, which would suggest that each trawler catches approximately 6.6-10 odontocetes per month which is about 1,100-1,700 odontocetes per year.

TABLE 4

THE FREQUENCY (%) THAT CALVES WERE SEEN IN THE FISHMARKETS: (NUMBER OF ANIMALS RECORDED AS CALVES/THE NUMBER OF ANIMALS WHICH APPEARED TO BE FULL GROWN)

Species	Number of calves/total number of observations	
Spinner Dolphin	52%	(11/21)
Spotted Dolphin	75%	(6/8)
Striped Dolphin	20%	(1/5)
Bottlenose Dolphin	0%	(0/3)
Risso's Dolphin	100%	(12/12)
Dwarf Sperm Whale	0%	(0/2)
Rough Toothed Dolphin	0%	(0/3)
False Killer Whale	0%	(0/1)
Cuvier's beaked whale	100%	(1/1)

5. *Direct Fisheries.*

The extent to which cetaceans are taken directly by fishermen is questionable. Although some fishermen harpoon dolphins, the catch does not appear to be extensive, nor is it a question of subsistence hunting, because the meat is not used for the survival of a community and the hunt is only practised by a few. Of the 72 cetaceans that I observed in fish markets, only four had deep wounds. It was unclear in my discussions with fishermen, however, if they had actually killed the animal or if the marks were made while the men hoisted it on to their boats with the help of a gaff or spear. Since there is little commercial incentive to kill dolphins, fishermen apparently hunt them only for sport or shark bait. I was told that Hindu and Buddhist fishermen do not hunt cetaceans and such skills will only be practised by Catholic and Muslim people.

In 1982, the crew of R/V *Tulip* witnessed a dolphin hunt while working offshore near a fishing village, Negombo (7°17′N, 79°40′E). We were following a school of Risso's dolphins, when two fishing boats approached us returning towards Negombo at 0830. Hand harpoons were brought out on both vessels and unsuccessful attempts made at harpooning the dolphins. On 15 March, 1983, a Cuvier's beaked whale calf was brought into the Trincomalee market with two large holes in the lower jaw and many smaller holes around the head and on the back in front of its dorsal fin. One man explained that fishermen actively take "these" animals during the months of March, April, and May for shark bait. "These" is in quotes because I could not establish if he referred only to the larger, beaked whales, or included other odontocetes as well. He estimated that there are ten boats which work out of Trincomalee Harbour that actively hunt these animals, killing 1-2 every three days for shark bait. Therefore, these boats may take 30-60 animals outside Trincomalee Harbour during the spring. Since there are 200 boats in Trincomalee town, ten boats represent 5% participation of fishermen directly killing cetaceans during the spring season.

6. *Habitat Modification.*

Populations of cetaceans off the coast of Sri Lanka may be threatened not only by indirect and direct exploitation, but also by habitat modification. As Sri Lanka becomes more industrialized, marine pollution (organic, inorganic and noise) will increase. Trincomalee Harbour is a good example of such changes. Undoubtedly it will become a major international and national port in the future. In addition, the largest river in Sri Lanka, the Mahaweli Ganga, flows northeast into Trincomalee harbour. This river, recently dammed to irrigate inland dry zones, now carries a vast amount of sediment and fertilizer. This murky plume entends out beyond Trincomalee harbour into the sea, directly altering the marine environment. For species that utilize these inshore waters, this habitat modification may be adversely affecting local populations.

CONCLUSION

The incidental entrapment of odontocetes by drift net fisheries is a global concern with substantial legal, biological, ethical and administrative problems.

Although this study focuses on the incidental entrapment of odontocetes in gillnets off the coast of Sri Lanka, it is clear that populations of cetaceans are threatened, endangered or at least harassed by gillnet fisheries wherever such nets and these animals occur together. Since the successful introduction of synthetic nets by FAO in Sri Lanka, these nets are now being utilized throughout the world (Eisenbud 1984). Yet, are these nets acceptable? Not only are animals (cetaceans, birds, turtles, fish, etc) entangled in nets while fishermen are using them, but entire nets, or parts of the gear are also lost at sea and continue to kill marine life indefinitely (Wallace 1984).

An international effort must be made to either replace gillnet fisheries with alternative fishing techniques, or to change the nets substantially so that non-target animals will avoid the nets. Gear experiments are presently being tested with drift net fisheries to decrease the incidental catch of Dall's purpoise, *Phocoenoides dalli,* in salmon gear (Kumagai *et al.* 1983), but more work needs to be done on an international scale. If we do not alter these nets or prevent their use, these nets may fish some populations of marine animals to extinction. Gillnet fisheries are multispecies operations. We have a moral obligation to stop the wasteful, useless and irresponsible catch of non-target animals by these nets, even if the consequence is economic loss.

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SEASONAL VARIATIONS IN THE COLOUR PATTERNS OF *COCCINELLA SEPTEMPUNCTATA* L. (COLEOPTERA, COCCINELLIDAE) IN NILGIRI HILLS, INDIA[1]

M. Rhamhalinghan[2]

(*With three text-figures*)

The first report on the seasonal melanization in *Coccinella septempunctata*, found in Mel Hosahatty, Nilgiris, 2000 m above MSL, is presented. It shows that there are two peaks of abundance, one extending from June to August and the other from October to February. Fifteen variations in the colour patterns of the variate *confusa* Weidemann have been recorded. The total melanics form about 6.05% of the general population and the relative frequencies of different patterns of the melanics and non-melanics (typicals) are presented. It is found from the present study that no single factor is responsible for the increase in the incidence of melanics, but temperature, relative humidity and solar radiation have a combined cumulative effect on the frequency of melanics.

INTRODUCTION

Melanism, in insects, appears to arise from various factors such as temperature, humidity, sunshine level, altitude, hormones, impairments in biochemical pathways and specific gene interactions (Dobzhansky 1933, Oshima *et al.* 1956, Kapur 1957, Richards and Davies 1972, Bengston and Hagen 1975, 1977; Ford 1975, Scali & Creed 1975, Bishop and Cook 1980, Sheng and Carver 1982). In Coccinellidae, lycopene combined with carotene α and β gives the reddish colour of the elytra (Richards and Davies 1972). The black pattern of the elytra is contributed by the localization of melanic chromogen (Gortner 1911, Tenenbaum 1935, Danneel 1943).

Dobzhansky and Sivertzev-Dobzhansky (1927) and Dobzhansky (1933) extensively studied the geographical variations in *C. septempunctata.* Varma (1954) emphasized variations in the colour patterns to be of great taxonomic value. He has studied the percentage of variates of *C. septempunctata* adults of Kanpur area during 1945-1950. Kapur (1959) studied the colour patterns of *C. septempunctata* var. *confusa* Weid. in the Eastern and Western Himalayas and the plains of North India. Sudha Rao (1962) gave an account of the inheritance of colour patterns in the *divaricata* Olive and *confusa* variates of *C. septempunctata* adults collected from the Northwest and Eastern Himalayas. Singh and Mann (1977) gave an account of colour aberrance in *C. septempunctata* from the semi-desert areas of Punjab during 1974-75. Rhamhalinghan and Manavalaramanujam (1983) reported for the first time the occurrence of *C. septempunctata* var. *confusa* in the Nilgiri Hills, South India. But the survey of Coccinellid literature shows that no work has been done on the seasonal variations in the colour patterns of *C. septempunctata* var. *confusa.* This is the first report on the seasonal melanization and their peak incidence.

MATERIAL AND METHODS

C. septempunctata were collected from Mel

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Hosahatty, Nilgiris area at altitude of about 2000 m above MSL from 1979 to 1982. In the field studies, two peaks of abundance of these populations are met with, once during October-February and the other during June-August. The species is rare in March, April, May and September due to lack of suitable cultivation and vegetation, resulting in the non-availability of aphids. It is a multivoltine species in this area.

Random population surveys were made in the fields and the specimens were grouped according to the degree of confluence of the elytral spots. The number of individuals in each group were recorded and the different elytral patterns are drawn.

The temperature, relative humidity and rainfall have been recorded throughout the period of this study to investigate the effects, if any, of these factors on the appearance of the variates under study.

In the laboratory, the melanics and the non-melanics were reared (Fig. 1) in transparent plastic containers of 7 cm diameter and 3 cm height with enough small pores on the lid for gaseous exchange. *Lipaphis erysimi* Kalt. were provided as food *ad libitum*. The results of observations made during 1980-81 only are discussed in this paper, and the data of other periods of study are presented wherever necessary.

RESULTS

In *C. septempunctata* L., the ground colour of the elytra is orange yellow and the aged insects acquire a crimson red colour. About 65% of the beetles collected were orange yellow and 35% crimson red in colour.

In the typical insect the first elytral spot is seen below the pronotum. The second and fourth spots are located on the lines externa one below the other, and the third spot is situated on the lines interna slightly inferior to the second spot as already reported by Varma (1954), (Fig. 2, Type 23).

Fig. 2 shows the elytral colour patterns in many population samples of *C. septempunctata* var. *confusa*, from various localities of Mel Hosahatty area. But the pronotal pattern is

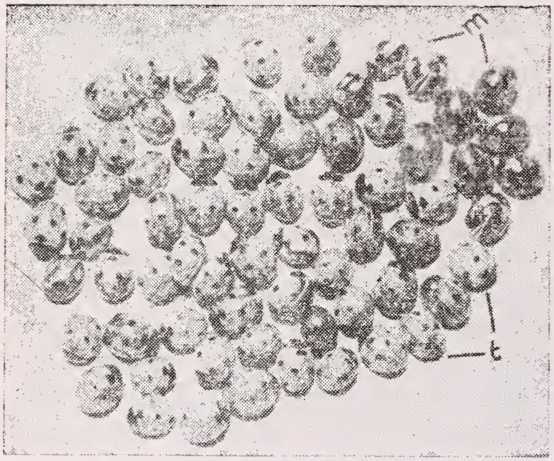

Fig. 1. The melanic (m) and the non-melanic typical (t) forms of *C. septempunctata*.

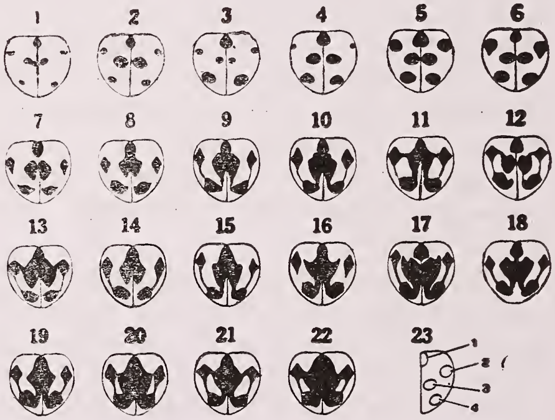

Fig. 2. *C. septempunctata* — variations in the colour patterns of the elytra. Types 1-7 — size variations of spots in the typical forms; types 8-22 — elytral patterns of var. *confusa* Weid.

more or less constant. In the Nilgiris, so far 15 variations in the colour patterns of *C. septempunctata* var. *confusa* have been recorded (Fig. 2, Types 8-22). In the typical forms collected, the size of the spots varies considerably and seven forms occur during the two peak seasons (types 1-7). They form the bulk of the total population (Table 1). Though several kinds of patterns may be formed by the confluence of two or more spots, the present study from 1979 to 1982 shows that not all of them occur during a particular sampling period viz., a period of one year, in a particular locality. This is in agreement with the statement of Kapur (1959), “the frequencies of patterns in a given species often differ in different areas and occasionally a pattern common in an area may be rare or absent in another area”.

TABLE 1

RELATIVE FREQUENCIES OF DIFFERENT PATTERNS OF THE TYPICALS OF *C. septempunctata* COLLECTED DURING 1981 IN MEL HOSAHATTY, NILGIRIS AREA

Months	Type: 1	2	3	4	5	6	7	Total
1981								
January	177	108	94	78	413	1	1	872
February	115	13	28	30	98	–	–	284
March	5	2	5	4	8	–	–	24
April	4	–	1	1	7	–	–	13
May	1	4	2	3	6	–	–	16
June	40	37	60	13	65	–	–	215
July	105	94	13	28	81	–	–	321
August	5	4	4	9	46	–	–	68
September	7	10	18	8	13	–	–	56
October	9	16	51	16	74	–	–	166
November	151	113	107	168	213	1	1	754
December	194	178	62	151	168	–	1	754
Total	813	579	445	509	1192	2	3	3543
Percentage	21.56	15.35	11.80	13.50	31.61	0.05	0.08	93.95

As such, the total melanics form 6.05% of the general population. The total melanics collected during 1980-81 were 228 out of a total of 3771 specimens.

The monthly occurrence of the *C. septempunctata* var. *confusa* Weid. is shown in Table 2. It is seen that only during winter does the frequency of melanics increase, but not in spring or in summer. During June and July too there is a slight increase in the incidence of *C. septempunctata* melanics. The data accumulated on the other periods of study (1979-80 & 1981-82) did not show any significant increase in their populations during those periods.

The typical *C. septempunctata* occur throughout the year. Yet one can find that the type 5 (fig. 2) with largest spots occurs abundantly during the peak seasons (31.61%). Next comes type 1, which forms about 21.56% of the total population. Type 2 occupies the third place (15.35%), type 4, fourth (13.50%) and type 3 fifth place (11.80%). Types 6

TABLE 2

RELATIVE FREQUENCIES OF DIFFERENT PATTERNS OF *Coccinella septempunctata* L. VAR. *confusa* WEID. COLLECTED IN MEL HOSAHATTY, NILGIRIS DURING 1981

Type: Months	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	Typicals	Grand Total	Melanics Total	Melanics %
1981																			
January	7	1	1	2	1	–	4	1	1	1	2	17	10	11	12	872	943	71	7.53
February	1	–	1	1	–	–	2	1	1	–	–	13	4	5	7	284	320	36	11.25
March	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	24	24	–	–
April	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	13	13	–	–
May	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	16	16	–	–
June	–	–	–	–	–	–	2	1	–	–	–	–	–	–	–	215	218	3	1.37
July	–	–	–	1	–	–	2	–	–	–	–	–	–	2	2	321	328	7	2.13
August	–	–	–	–	–	–	–	–	–	–	–	–	–	–	4	68	72	4	5.55
September	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	56	56	–	–
October	–	–	1	–	–	–	1	–	–	–	–	–	–	–	4	166	172	6	3.49
November	2	–	1	2	–	–	6	1	–	–	1	4	5	10	7	754	793	39	4.9
December	2	–	1	3	1	2	5	1	2	–	3	8	15	11	8	754	816	62	7.59
Total	12	1	5	9	2	2	22	5	4	1	6	42	34	39	44	3543	3771	228	6.05
Percentage	0.32	0.03	0.13	0.24	0.05	0.05	0.58	0.13	0.11	0.03	0.16	1.11	0.90	1.03	1.17	93.95	–	6.05	–

and 7 are very rare. Table 1 gives the incidence of typical forms. A comparison of the incidence of melanics from different areas in India is given in Table 3.

TABLE 3

INCIDENCE OF MELANICS IN DIFFERENT PARTS OF INDIA

Area	Year of study	Total specimens examined	Percentage of melanics	Authority
Kanpur	1945-50	1072	19.55%	Varma B. K. (1954)
E. Himalaya	1959	792	22.98%	Kapur A. P. (1959)
W. Himalaya	1959	178	10.68%	„ „
Plains of North India	1959	230	6.09%	„ „
Nilgiris	1981	3771	6.05%	Rhamhalinghan & Manavalaramanujam (1983)

According to Varma (1954), the melanics form 19.59% of the general population in the Kanpur area, which is noted for its extreme cold winter, which could be a major factor for the occurrence of the *C. septempunctata* L. var. *confusa* Weid. as in the Himalayan areas.

DISCUSSION

According to Prosser (1973), temperature appears to influence the colouration of many animals significantly. Though the colour and colour patterns are genetically determined, their manifestation is largely determined by temperature (Sheng & Carver 1982). Seasonal temperature-dependent colour variation has been reported in Orthoptera, Phasmida, Heteroptera, Lepidoptera and Hymenoptera (Richards & Davies 1965, Wigglesworth 1973, Sheng & Carver 1982).

Hodek (1973) states that manifestation of genes may also be influenced by temperature, i.e. either through hereditary or somatic factors. In *Epilachna chrysomeline* Fabr. the total area of spots decreases by 30 to 55% when temperature increases from 20°C to 35°C. He has also cited evidence for the increase in pigmentation with the humidity of the region. It is also said that pigmentation merely coincides with changes in the physiological processes of the organisms.

According to Dobzshansky (1959) pigmentation increases in humid and cool climates and decreases in dry and hot climates, the humidity being apparently far more effective than temperature. Lusis (1961) agrees with Dobzshansky (1959) in that high humidity may influence the appearance of melanic forms.

The results of the present study proves the statement of Dobzshansky. During the winter between November and February the relative humidity ranges from 82 to 86%. During this three-month period, the temperature is found to be very low. (Mean max. 20.6°C: mean min. 7.8°C) (Fig. 3). Humidity and low temperature might have produced melanism in these insects. During the summer months the comparatively high temperatures (mean max. 25.7°C: mean min. 10.1°C: mean RH 75%) and low humidity result in the absence of the melanics. Yet, around July the relative humidity (82 to 92%) is equally high and it coincides with the occurrence of the melanic forms (Fig. 3). Studies made in the previous years (1979-80) also showed similar incidence.

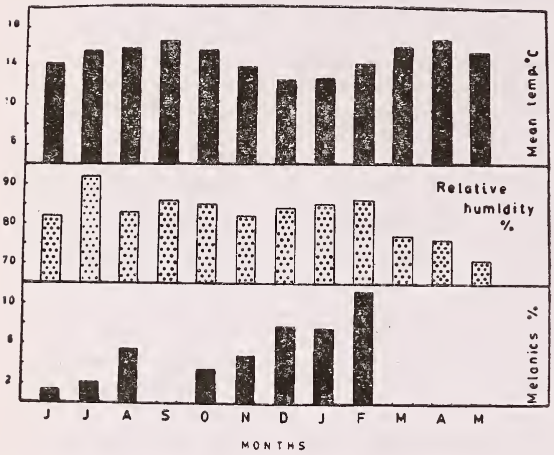

Fig. 3. Histogram showing the relationship between melanic frequency, relative humidity, and temperature.

It has been reported by Lusis (1961) and Benham *et al.* (1974) that a decrease in the total amount of sunshine favours melanics. From June to August, when the southwest monsoon is active, the sky is cloudy and misty which inhibits the intensity of light, sometimes continuously for the whole period or for at least some 60 to 70 days. The same conditions also prevail during the northeast monsoon. Almost continuous torrential rain, and high humidity of the atmosphere during October inhibit the light intensity. For most of the days the sky in winter is also cloudy. The ultraviolet radiation is thus reduced to almost undetectable levels. But Nayar (1977) has stated that at high altitudes, the effect of cosmic rays induces black pigmentation in such insects as *Eristalis tenax* L.

Moreover, during monsoon periods the average rainfall increases. The rainfall, the low sunshine level, and high humidity might be the causative factors for the appearance of melanics.

But during 1982, the failure of southwest monsoon created a much favourable condition and due to the significantly low rainfall, the mortality of the coccinellids was reduced and the population size suddenly increased during June, July and August. Yet, during this period the sky was cloudy and misty. The low temperature, decrease in the amount of sunshine and the increase in humidity resulted in the appearance of large number of *confusa* variate in this period also.

Though the average monthly temperature during 1981 shot up to 24.1°C maximum and the minimum temperature was 6.7°C, in the previous years the temperature recorded was lower than this. Singh & Mann (1976) suggest that severe hot climatic effects (i.e. less humidity and more heat) bring about melanization as well as scarcity in spotting pigmentation. This statement is contradictory to the present observation and to the arguments of most of the authors.

Muggleton *et al.* (1975) suggested that the melanics of *A. bipunctata* have greater ability to absorb solar radiation. This advantage may be important in cooler and less sunny environments. Moreover, their experiments showed that the melanic morphs have higher internal temperatures and greater activity than the typical morphs. A similar condition exists in the nymphs of *Locusta migratoria migratorioides.* The development of the black pigments leads to increased activity in the nymphs of *gregaria* (Richards & Davies 1965). Since these nymphs absorb more radiant heat, their internal body temperature is higher than the green and brownish *solitaria* nymphs.

In the field, one can readily observe that the melanics of *C. septempunctata* are so active that it is difficult to handle them alive. Even in laboratory studies they are found to be extremely active.

Altitude is another factor involved in the melanic frequency (Kapur 1957, Nayar 1977). In his work on the populations of *Adonia variegata* Goeze at different altitudes, Kapur (*loc. cit.*) has shown that the melanic pigmentation of populations distinctly increases with the altitude. The results of the present study support the views of Kapur. The plains of North India, with their latitude and Nilgiri Hills with their altitude, do not show a great difference in the percentage of melanics, as shown in Table 3.

The conclusions and interpretations presented in this paper are based on the data available for this particular locality and the results of most of the works show that low temperature, high humidity, high altitude and low sunshine level are some of the causative factors increasing melanism (see the reviews by Prosser 1973, Ananthakrishnan & Viswanathan 1976, Kapur 1957, 1959; Dobzhansky 1933, 1959; Richards & Davies 1965, Hodek 1973, Wigglesworth 1973). But there are controversial and conflicting statements from several authors (Nayar 1977, Singh & Mann 1977, review by Muggleton 1978).

The veracity of these interpretations might not be questioned or rejected, since the melanic frequency of a population is the result of the interaction of a number of selective factors (Muggleton 1978). Further, the influence of these environmental factors may vary geographically (Bengtson & Hagen 1977) and no one can expect any uniform trend in their action. Moreover, the percentage of melanics in an area may vary from time to time, depending on the conditions of the abiotic factors, and there are also individual variations among the melanics. This clearly shows that melanization depends upon the physiological conditions of the individuals concerned and they respond differently to similar or diverse environmental conditions. Thus most, or a few, members of a population in a given area, may not react to the influence of any one factor or cumulative influence of several factors. Yet, in some forms any one of the factors is sufficient to trigger the pattern formation, as proved experimentally in *Aphidius smithi* (Sheng & Carver 1982).

However, the present study has shown that more than one factor is responsible for melanization and all the environmental changes have a cumulative effect on the frequency of the melanics. It is unfortunate that the occurrence of the melanics from various regions of India have not yet been studied. A similar study, when undertaken in other localities in the Indian subcontinent, might well throw more light on the biology and ethology of these beetles.

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FIELD BIOLOGY OF *NESOKIA INDICA* WITH REFERENCE TO ORCHARDS OF BALUCHISTAN (PAKISTAN)[1]

Afsar Mian[2]

The biology of 122 individuals of *Nesokia indica* trapped from orchards of Quetta, Pishin, Zhob, Loralai and Khuzdar is analysed from distribution of age structure, sex and reproductive parameters in three seasons (autumn, winter and spring). The results indicate that the population is balanced with regard to sex, though males/females in higher age classes show differential activity levels. Females are reproductively active throughout the year with a reproductive peak in spring and summer. The species appears to be a less prolific breeder in the area.

INTRODUCTION

The Short-tailed Bandicoot Rat or the Short-tailed Mole Rat, *Nesokia indica* Gray and Hardwicke, 1852, is known from various distributional and biological notes from Iran (Lay 1967), Iraq (Walker *et al.* 1964), southern Sind (Wagle 1927, Fulk and Khokhar 1977), and Faisalabad (Taber *et al.* 1967, Begum and Beg 1980, Roberts 1977). Roberts (1974) associated this species with irrigated plantations. Apropos to our survey of the vertebrate pests of orchards of Baluchistan, which indicated that *N. indica* is a significant pest to orchard plantation in highland desert valleys (Mian *et al.* 1988a, 1988b), we became interested in the ecology of the species, which has been neglected in the area. The paper attempts at reporting some preliminary data on the biology of this important pest with relevance to Baluchistan (Pakistan).

MATERIAL AND METHODS

122 individuals of *N. indica* were captured between October, 1983 and May, 1984 from orchards of Quetta (74), Khuzdar (1), Kuchlag (12), Pishin (11), Bund Khushdil Khan (2), Gulistan (14), Zhob (7), and Loralai (1) by steel snap traps (size 17.5 × 9.5 cm.) baited with pieces of apple. Each of the trapped animals was injected 1-5 ml of commercial grade formaline (saturated solution of formaldehyde) through intraperitoneal route. Different samples were bagged in cellophane bags and brought back to the laboratory for further analysis. As all the individuals were collected from the areas sharing similar physical and biotic conditions, the data was pooled for further analysis of various biological parameters of the species concerned in relevance to orchards of the highland deserts of Baluchistan.

Each individual was sexed and weighed (up to 0.1 g by using Ohios single pan balance). The data was analysed for the distribution of males and females in different regional/seasonal samples and in different age groups. The weight classes, representing different ages (juvenile, less than 80 g; early adult, 81-130 g; adult 131-170 g; older adult, more than 170 g) were adopted from Begum and Beg (1980). Each female was checked for open/plugged nature of vagina, for spotting any recent mating. The uteri were physically examined for pregnancy status and for uterine

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scars, as an indication of recent pregnancy. The embryos, wherever present, were weighed upto 0.1 g. The number of mammary glands and their lactating status was recorded visually. In males, the gonadal status was recorded.

Statistical analysis was carried out following appropriate methods outlined by Sokal & Rohlf (1969).

RESULTS

(1) *Sex Ratio*: Table 1 presents data regarding the distribution of males and females in different areas, seasons, age classes and in the overall sample of the species. The sex ratio of 1:1 is maintained in the overall sample of the species. The data suggests that except for Loralai and Khuzdar (very low trap success indicating a very low population level), the population is balanced with respect to the distribution of the two sexes in different geographic localities. It is also obvious that a normal sex ratio is maintained in the three seasonal samples (autumn, winter, spring). The males and females appear to be equally distributed in juvenile and early adult classes; however, the sex ratio is grossly skewed in the two higher age classes, i.e., adults (in favour of females) and older adults (in favour of males).

TABLE 1

DISTRIBUTION OF MALES AND FEMALES IN *N. indica*, SAMPLED FROM DIFFERENT AREAS, SEASONS AND IN DIFFERENT AGE CLASSES

		Male	Female	Sex ratio (Male: Female)
Area	Quetta	33	41	0.80:1
	Pishin	23	16	1.44:1
	Zhob	5**	2**	2.50:1
	Loralai	—	1*	—
	Khuzdar	1*	—	—
Season	Autumn	22	26	0.85:1
	Winter	22	17	1.29:1
	Spring	16	19	0.84:1
Age Class	Juvenile	7	4	1.75:1
	Early Adult	22	24	0.92:1
	Adult	14†	25†	0.56:1
	Older adult	19††	7††	2.71:1
Total		60	62	1.03:1

*Number of specimens trapped is low and hence cannot be subjected to statistical analysis.

**Not significant using Yate's correction for continuity.

†Chi²(1) = 3.1026 ††Chi²(1) = 5.4146.

(2) *Age Structure*: The distribution of different age classes in three seasonal, and the pooled, samples is presented in Table 2. It suggests the relative preponderance of early adult (37.72%), adult (30.06%) and older adult (22.47%) classes and a relative scarcity of juveniles (9.75%), in the total sample. However, it appears that there is a gradual increase in the representation of juvenile class from autumn (5.41%) to winter (9.57%) and spring (14.29%). A similar trend seems to be followed in the class, represented by 19.41%, 30.29% and 40.48% in autumn, winter and spring respectively. The early adult class dominates the autumn (50.73%) and winter (51.00%) samples, but its representation decreases sharply in spring (11.43%). The proportionate representation of the older adult class has a marked decrease in winter sample (9.14%).

(3) *Reproduction*: The data on the reproductive status of 60 females, in different seasons and age classes, is presented in Table 3. The table suggests that females with visible pregnancy are present in all the seasonal samples, suggesting that females remain sexually active throughout the year. However, there is a higher proportion of the females with visible ovaries in spring (69.3%), followed by winter (46.0%) and autumn (7.5%). Similarly, the proportion of females with visible signs of

TABLE 2

DISTRIBUTION OF FOUR AGE CLASSES (PERCENTILE) IN DIFFERENT SEASONS IN *N. indica*

Season	No.	Age class			
		Juvenile	Early Adult	Adult	Older Adult
Autumn	48	5.41	50.73	19.41	24.45
Winter	39	9.57	51.00	30.29	9.14
Spring	35	14.29	11.43	40.48	33.82
Total	122	9.75	37.72	30.06	22.47

TABLE 3

DISTRIBUTION OF DIFFERENT CLASSES OF FEMALES WITH REGARD TO REPRODUCTIVE STATUS IN DIFFERENT SEASONS AND AGE CLASSES IN *N. indica*

		Season			Age class			
		Autumn	Winter	Spring	Juvenile	Early Adult	Adult	Older Adult
No. Examined		27	16	17	4	24	25	7
Gonadal Status	Visible	0.075	0.460	0.540	0.00	0.191	0.560	0.857
	Invisible	0.925	0.540	0.460	1.00	0.809	0.440	0.143
Pregnancy Status	Plugged	0.000	0.000	0.270	0.00	0.000	0.080	0.143
	Visible Pregnancy	0.090	0.285	0.110	0.00	0.048	0.200	0.286
	Scars	0.335	0.105	0.110	0.00	0.286	0.120	0.143
	Total				0.00	0.334	0.400	0.572
Av. No. Embryos		3.5	2.5	4.00				
Av. No. Scars		4	4	4				
Av. Weight of Embryo (g)		5.80	7.15	1.37				

pregnancy (pregnant or plugged) gradually decreases from spring (38.7%) to winter (28.5%) and autumn (9.5%). A higher proportion of the females of spring sample (27.7%) bore vaginal plugs, whereas none was seen in winter or autumn. All these collectively indicate that the species is reproductively more active during summer and least in autumn. The higher percentage of the females of autumn sample (33.5%) showing uterine scars, also suggests the presence of a higher reproductive activity during the previous summer.

A higher proportion of the females with visible pregnancy is present in winter sample (28.5%) as compared to spring (11.0%) or autumn (9.5%).

The average number of embryos per pregnant female was the minimum in winter sample (2.5), followed by autumn (3.5), and was highest in spring (4.0). The average weight of the embryo exhibits a reverse pattern, being highest in winter (7.15 g), followed by autumn (5.8 g) and lowest in spring (1.37 g). The average number of the uterine scars, however, remains constant in all the seasonal samples, and all the females examined constantly bore four scars.

The smallest pregnant female trapped in our sample weighed 113.0 g though a female bearing scars, showing a previous pregnancy, weighed 101.5 g. However, no female with any sign of reproductive activity is recorded in juvenile age class. Females showing sign of pregnancy constitute 20% (5.45% with vaginal plugs and 14.55% with visible pregnancy) of the overall female population. The proportion of females with visible ovaries increases from 0.00% in juvenile class to 19.05%, 56.00% and 85.71% in early adult, adult and older adult classes respectively. Similarly, the proportion of females showing signs of reproductive activity (with vaginal plugs, visible pregnancy or uterine scars) increases from 0.00% to 33.33%, 40.00% and 57.15% in different, progressively increasing age classes. Females showing signs of pregnancy also increase from 0.00% in juvenile class to 4.76% in early adult, 28.00% in adult and 42.86% in older adult classes.

DISCUSSION

(1) *Sex Ratio*: The sex ratio of 1:1 maintained in the overall population as well as in regional and seasonal samples, suggests that the population is balanced with regard to distribution of males and females, and no behaviourial sexual dimorphism exists in this species. The presence of skewness in favour of females in adult and in favour of males in older adult classes can be explained on the basis of a differential behaviour and/or activity of the members of the two sexes at different ages. Further studies are required to prove this hypothesis, which suggests that females are more active in adult and males in older adult classes. Such a difference in activity of the two sexes has been previously reported for a number of rodent species (Shadown 1963, Faust *et al.* 1971, Bigler and Jenkins 1975, Rana and Beg (1976), though Fisler (1971) could not find any difference in the level of activity of the two sexes of *Reithrodontomys* sp. at any reproductive stage.

(2) *Age Structure*: The general paucity of juveniles in our samples suggests a tendency of their staying in and/or around their maternal burrows, rendering them less vulnerable to trapping. The fact that the smallest individual trapped weighed 37.4 g, and that most of the juveniles in our samples weighed between 60 g and 90 g, yields some degree of support to the hypothesis. Though more data is needed on the home range, such a phenomenon has been reported to cause sampling artifact in other rodent species, like *Rattus* sp. (Harrison 1966), *Bandicota bengalensis* (Spillett 1968), and *Mus musculus* and *M. booduga* (Rana and Beg 1976).

The shift in the age structure during different parts of the year can be conveniently explained on the basis that the maximum reproductive activity and recruitment of the new individuals in the population occur during spring and summer, and death of the individuals of older classes during winter.

(3) *Reproduction*: The presence of reproductively active females in all the seasonal samples suggests that *N. indica* remains reproductively active throughout the year, generally agreeing with previous observations (Faisalabad, Punjab — Taber *et al.* 1967, Iran — Lay 1967, Punjab, Pakistan — Roberts, 1977, Iraq — Walker *et al.* 1964). However, it appears that the species is reproductively most active during spring, followed by winter, and is least active in autumn. The high proportion of females with vaginal plugs in the spring sample, and uterine scars in autumn also suggest maximum mating and pregnancy rate in spring/summer.

A higher proportion of the females showing pregnancy in the winter sample, appears hard to explain in the wake of extreme environmental conditions of temperature, snowfall/rainfall and scarcity of vegetation. Further, a relative scarcity of females bearing scars in the spring sample also indicates scarcity of pregnant females in winter. It appears that the preponderance of pregnant females in the winter sample is caused by higher activity level of these females, as may be needed for higher energy requirements of this predominantly herbivore rodent. If further studies prove our hypothesis, then trapping in the orchards, having comparatively better vegetation, may deprive the species of the potential recruits, causing a greater damage to the species.

The presence of only four scars in all the females and a single reproductive episode suggest that, on an average only one litter is produced per female per annum. This is in sharp contrast to observations of Fulk and Khokhar (1977) from southern Sind, where up to 21 scars have been recorded in some females, corresponding to five average litters. The present data on the number of foetuses per pregnant female agree with the one collected from Iran (Llyod 1909), though it remains below that recorded by Roberts (1977) for Punjab. The corroboration of the data on the uterine scars and average number of foetuses allows us to suggest that, in this region females initially implant four embryos. Some of these embryos are then flushed out, maximum flushing occurring in winter (1.5 per female), followed by autumn (0.5) and virtually no flushing out of the embryos occurs in spring. It appears that harsh environmental conditions in winter forces a maximum flushing out of the embryos, while optimal conditions in spring allow the development of all the embryos. Further studies are needed to know the significance of such a reproductive behaviour of the species.

The pattern of annual recruitment and production of reproductively active individuals in spring/summer fully conforms with the vegetative cycle of the area, suggesting that this predominantly herbivore species is fully adapted to the area. The presence of only one reproductive peak, fewer number of foetuses, and only 20% of the females showing signs of reproductive activity, all suggest that the species is not a very prolific breeder in the area, which agrees with the previous observations from other parts of its range (Roberts 1977).

The fact that none of the juvenile individuals (weighing less than 80 g) exhibited any sign of reproductive activity agrees with previous reports (Begum and Beg 1980, Fulk and Khokhar 1977).

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OBSERVATIONS ON BIRDS ON MUNDANTHURAI PLATEAU, TAMIL NADU[1]

JUSTUS JOSHUA AND A. J. T. JOHNSINGH[2]

(*With a text-figure*)

One hundred and fifty nine bird species, representing 93 genera and 40 families, were identified on Mundanthurai Plateau from January to December, 1984. Of these, 77 were classified as residents, 41 as winter visitors, 30 as altitudinal migrants and two as summer visitors. The status of nine species could not be ascertained. Mundanthurai Plateau has five species of kingfishers, including the Blackcapped (*Halcyon pileata*). However, only two species of woodpeckers (*Dinopium benghalense* and *D. javanense*) were seen. There was one observation of a Grey junglefowl (*Gallus sonneratii*) hen nesting on a tree with five eggs and many on the interactions between primates and birds.

INTRODUCTION

One of the major benefits of bird community studies in forested habitat and estimation of abundance of bird species is that the studies, when repeated after several years, could help in assessing the status of bird species themselves and their habitat. Published reports on such time-span observations are rare in India, and the only paper we have seen is by Ripley (1978) who had an impression of relative 'scarcity' when be visited the Simlipal hill in Orissa after a span of 28 years.

In recent years, however, there are quite a few bird community studies (Gaston 1978, Johnsingh *et al.* 1987, Khan 1978, Price 1979) which give us some baseline data on birds for certain habitats of the country which can be used for future comparisons. The paper presented here, based on our field studies on Mundanthurai Plateau, adds a little more information. It also shows how simple natural history observations still could collect interesting information on birds as exemplified by our observations on the nesting behaviour of a female grey junglefowl and interactions between birds and primates.

STUDY AREA

Mundanthurai Plateau (*c.* 60 km^2) situated in Mundanthurai Wildlife Sanctuary (572 km^2, 8° 40′ N, 77° 20′ E) in Tamil Nadu is 180-200 metres above MSL. The Plateau receives both the Southwest (June-August) and the Northeast (October-December) monsoon. Ten years of rainfall data (1974-84) give an average of 1708 mm for upper Papanasam reservoir station and 1189 mm for the lower Papanasam reservoir station, both of which are situated on the plateau.

Two distinct vegetation types, riverine forests along the perennial Tambiraparani and Servalar rivers, and dry deciduous forests in other parts, occur on the Plateau. Trees of the riverine forest are dominated by Dipterocarpaceae and dry deciduous forest by Leguminosae. The riverine forests of the plateau which now average around 20 metres in width were once continuous with the evergreen forests of the higher

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altitudes of the catchment area. This continuity was broken by the construction of the upper Papanasam reservoir (1938-43) across the river Tambiraparani and by the servalar reservoir across Servalar River 1974-1987). Both the rivers merge near Mundanthurai forest rest house and flow as Tambiraparani River for a kilometre before emptying into lower Papanasam reservoir which lies within the intensive study area of 20 km². (Fig. 1).

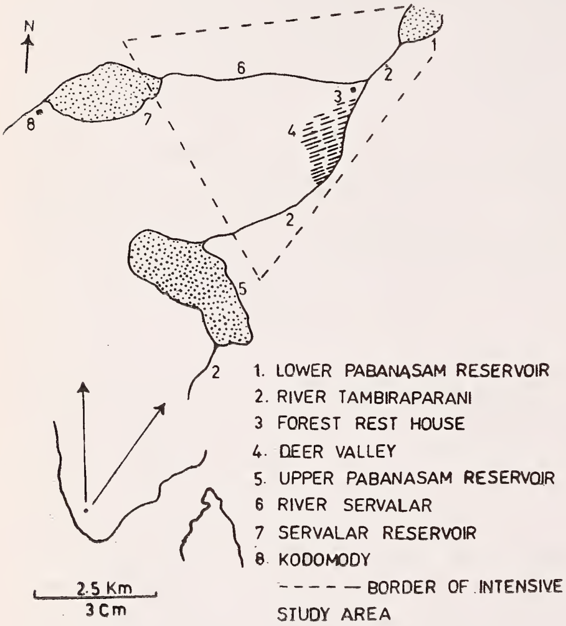

Fig. 1. Diagrammatic sketch of the study area and adjacent places of Mundanthurai Plateau, Tamil Nadu.

In the 1960's some areas of the dry deciduous forests were cleared and planted with sandal (*Santalum album*), teak (*Tectona grandis*), *Eucalyptus* and soft wood species such as *Ailanthes excelsa* and *Ceiba pentandra.* These plantations, except teak and *Eucalyptus,* failed as a result of browsing by sambar (*Cervus unicolor*), the common cervid of the Plateau.

In most areas, regeneration of the natural vegetation is successful but in Deer Valley (*c.* 1.25 km²) which has been subjected to intense cattle grazing and fires, the secondary thicket vegetation is mostly of *Dichrostachys cinerea, Helicteres isora* and *Cymbopogon citratus.* As a result of these habitat modifications the Plateau has a mosaic of habitat which includes areas with sparse vegetation, areas with dense secondary vegetation, plantations, dry deciduous forests, riverine forests and a reservoir. The diversity of habitat attracts a large variety of birds.

METHODS

The study was conducted from January to December, 1984 and data on birds were collected by two methods. First, when a bird was seen or heard anywhere in the study area, at any time, it was noted down. This gave us presence or absence data for the study period. Second, all birds seen along three selected one kilometre transects — one in the Deer valley, one along the west bank of the river Tambiraparani, and one through the dry deciduous forests on the southern side of river Tambiraparani, were recorded. The river transect was walked 24 times, all in the mornings, eight times each during March-April, July-August, and November-December. The other transects were walked 15 times, all in the mornings, five times each during March-April, July-August, and November-December. This transect study gave us presence or absence data as well as quantitative information on the abundance of birds which will be published elsewhere (Johnsingh & Joshua, in prep.). In the following account, birds are classified as rare, frequently seen and common, based on the number of sightings and abundance.

OBSERVATIONS

A total of 159 birds, representing 93 genera and 40 families, were recorded. Of these 77 were residents, 41 winter visitors, 30 altitudinal migrants and two summer visitors. We could not ascertain the migratory status of nine species (Table 1). More bird species visited the plateau from October to February ($\bar{x} = 119$) than during March to July ($\bar{x} = 83$). This difference was significant ($t = 4.9$, $p < 0.01$).

Rarity of certain bird species on the Plateau is due to their naturally low population in nature (e.g., King and Egyptian vulture), requirement of a specialised habitat which is rare in the study area (e.g., reed patches for Black Bittern), paucity of birds themselves in the study area (e.g., Grey Partridge), or migratory nature (e.g., Redwinged Cuckoo, Indian Pitta). Birds frequently seen, but which did not occur in large number, include species such as Greyheaded Fishing Eagle, Crested-hawk Eagle and Crow-pheasant. These, being predatory and territorial, can only occur widely spaced and in few numbers. Birds coming under the category of 'common' include largely frugivorous birds (e.g., Roseringed Parakeet, Koel), omnivorous birds (e.g., Myna, Bulbuls), granivorous birds(e.g., doves) and small insectivorous birds (e.g., House Swift, Green Bee-eater, Chloropsis), many individuals of which can be supported by a forest ecosystem.

The avifauna of the plateau is interesting in several respects. Five species of kingfishers including the Blackcapped, which is, however, rare on the Plateau, are seen usually in the months of January and February. Blackcapped kingfisher frequents mangrove swamps, tidal creeks and the seashore and is occasionally met with on rivers considerably inland from the sea, e.g., Parambikulam River near Kuriar Kutty from altitudes of 500 m down to the mean sea level (Ali 1969). Blackcapped kingfisher seems to be rare in other forest areas in south India. For instance, Ajay Desai (pers. comm.) has not seen it in Mudumalai-Bandipur-Nagrahole sanctuary complex, although the other four species of kingfishers seen on Mundanthurai Plateau are common. In Periyar Tiger Reserve, five species of kingfishers are seen but not the Blackcapped (Nair *et al.* 1985). It would be worth investigating the ecological reasons which attract the Blackcapped kingfisher to Mundanthurai from September to March.

Twelve species of woodpeckers occur in Kerala (Ali 1969). In Parambikulam, eight species have been recorded (Vijayan 1978), in Periyar nine species (Nair *et al.* 1985) and seven species in a study area of sholas, tea, *Eucalyptus* and Acacias in Nilgiris (Khan 1978). Only two species of woodpecker (Lesser Goldenbacked and Threetoed Goldenbacked) were seen on Mundanthurai Plateau. We attribute the paucity of woodpecker species on the Plateau to the small size of the study area (20 km^2) and the restriction of large boled trees mostly to the thin belt of riverine forests. Dry deciduous forests in the study area, both natural as well as with secondary vegetation, typically have trees with slender boles. Large scale collection of dead wood by the fire wood cutters which are necessary as nesting sites may also be another factor limiting the number of woodpecker species.

It is interesting to note that some species that are rare or absent on the plateau are common in the adjoining semievergreen and evergreen forests of the upper slopes (>500 m). Species such as Malabar Trogon (*Harpactes fasciatus*), Blackheaded Oriole (*Oriolus xanthornus*), Whitebellied Tree Pie (*Dendrocitta leucogastra*) and Slatyheaded Scimitar Babbler (*Pomatorhinus horsfieldii*) were seen beyond upper Papanasam reservoir and Kodomody but not on the Plateau. Both the hornbills (Malabar Grey Hornbill and Great Pied Hornbill) were more frequently seen in the

TABLE 1

BIRDS SEEN ON MUNDANTHURAI PLATEAU FROM JANUARY TO DECEMBER, 1984

Family and scientific name	Common English name	Months during which birds were seen J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
PHALACROROCIDAE															
Phalacrocorax niger	Cormorant	+	+	+	+	+	+	+	+	+	+	+	+	2	Am
Anhinga rufa	Darter	+	+	+	–	+	+	+	+	+	+	+	+	1	Am
ARDEIDAE															
Ardea cinerea	Grey Heron	+	+	–	–	–	–	–	–	–	–	+	–	1	WV
Ardeola striatus	Little Green Heron	+	+	–	–	–	–	–	–	–	–	+	+	1	WV
Ardeola grayii	Pond Heron or Paddybird	+	+	–	–	–	–	–	–	–	+	+	+	2	WV
Egretta intermedia	Smaller Egret	+	+	–	–	–	–	–	–	–	–	–	–	1	WV
Egretta garzetta	Little Egret	+	–	–	–	–	–	–	–	–	–	–	+	1	WV
Nycticorax nycticorax	Night Heron	+	+	–	–	–	–	–	–	–	–	–	+	1	WV
Ixobrychus flavicollis	Black Bittern	+	–	–	–	–	–	–	–	–	+	+	+	1	WV
CICONIIDAE															
Mycteria leucocephala	Painted Stork	+	–	–	–	–	–	–	–	–	–	–	–	1	WV
Ciconia ciconia	White Stork	+	+	–	–	–	–	–	–	–	–	–	–	1	WV
ACCIPITRIDAE															
Elanus caeruleus	Blackwinged kite	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Milvus migrans govinda	Pariah Kite	+	+	+	–	+	–	+	+	–	+	+	+	2	Am
Haliastur indus	Brahminy Kite	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Accipiter badius	Shikra	–	–	+	+	+	–	–	+	–	+	–	–	1	R
Accipiter nisus nisosimilis	Sparrow-Hawk	+	–	+	+	+	–	+	+	+	+	+	+	2	R
Buteo rufinus	Longlegged Buzzard	+	–	–	–	–	–	–	–	–	+	–	–	1	Am
Buteo buteo japonicus	Japanese Buzzard	+	–	–	–	–	–	–	–	–	+	–	–	1	Am
Spizaetus cirrhatus cirrhatus	Crested Hawk-Eagle	–	+	+	–	–	–	–	–	–	+	–	–	1	R
Hieraaetus pennatus	Booted Hawk-Eagle	–	+	–	–	–	–	–	–	–	–	–	–	1	Am
Aquila rapax vindhiana	Tawny Eagle	–	+	–	–	–	–	–	–	–	–	–	–	1	Am
Ictinaetus malayensis	Black Eagle	+	+	–	–	–	–	–	–	–	–	–	–	1	Am
Ichthyophaga ichthyaetus	Greyheaded Fishing Eagle	+	+	–	+	+	–	+	+	+	+	+	+	1	A
Sarcogyps calvus	Black or King Vulture	–	+	–	–	–	–	–	–	–	–	–	–	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Neophron percnopterus	Egyptian or Scavenger Vulture	+	+	–	–	–	–	–	–	–	+	–	–	1	Am
Spilornis cheela	Crested serpent Eagle	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Pandion haliaetus	Osprey	+	–	–	–	–	–	–	–	–	–	–	–	1	WV
FALCONIDAE															
Falco biarmicus jugger	Laggar Falcon	–	+	–	–	–	–	–	–	–	–	+	–	1	R
PHASIANIDAE															
Francolinus pondicerianus	Grey Partridge	–	–	–	–	–	–	–	+	–	–	–	–	1	R
Galloperdix spadicea	Red Spurfowl	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Galloperdix lunulata	Painted Spurfowl	+	+	–	–	–	–	–	–	–	–	–	–	1	R
PHASIANIDAE															
Gallus sonneratii	Grey or Sonnerat's Junglefowl	+	+	+	+	+	+	+	+	+	+	+	+	2	R
TURNICIDAE															
Turnix sylvatica	Little Bustard Quail	–	–	–	–	+	+	–	–	–	–	–	–	1	UK
Turnix suscitator	Common Bustard Quail	–	–	–	+	+	+	+	+	–	+	–	+	1	R
RALLIDAE															
Amaurornis phoenicurus	Whitebreasted Waterhen	+	+	–	–	–	–	–	–	–	+	+	+	1	WV
CHARADRIIDAE															
Vanellus indicus	Redwattled Lapwing	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Vanellus malabaricus	Yellowwattled Lapwing	–	–	–	+	+	+	+	–	–	+	–	–	1	SV
Charadrius dubius	Little Ringed Plover	+	–	–	–	–	–	–	–	–	–	–	–	1	WV
Tringa hypoleucos	Common Sandpiper	+	+	+	–	–	–	–	–	–	+	+	+	1	WV
Gallinago stenura	Pintail Snipe	–	–	+	–	–	–	–	–	–	+	–	–	1	WV
COLUMBIDAE															
Treron pompadora	Pompadour or Greyfronted Green Pigeon	+	+	–	–	–	–	–	+	+	+	+	+	1	Am

TABLE 1

BIRDS SEEN ON MUNDANTHURAI PLATEAU FROM JANUARY TO DECEMBER, 1984

Family and scientific name	Common English name	J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
PHALACRORORACIDAE															
Phalacrocorax niger	Cormorant	+	+	+	+	+	+	+	+	+	+	+	+	2	Am
Anhinga rufa	Darter	+	+	+	–	+	+	+	+	+	+	+	+	1	Am
ARDEIDAE															
Ardea cinerea	Grey Heron	+	+	–	–	–	–	–	–	–	–	+	–	1	WV
Ardeola striatus	Little Green Heron	+	+	–	–	–	–	–	–	–	–	+	+	1	WV
Ardeola grayii	Pond Heron or Paddybird	+	+	–	–	–	–	–	–	–	+	+	+	2	WV
Egretta intermedia	Smaller Egret	+	+	–	–	–	–	–	–	–	–	–	–	1	WV
Egretta garzetta	Little Egret	+	–	–	–	–	–	–	–	–	–	–	+	1	WV
Nycticorax nycticorax	Night Heron	+	+	–	–	–	–	–	–	–	–	–	+	1	WV
Ixobrychus flavicollis	Black Bittern	+	–	–	–	–	–	–	–	–	+	+	+	1	WV
CICONIIDAE															
Mycteria leucocephala	Painted Stork	+	–	–	–	–	–	–	–	–	–	–	–	1	WV
Ciconia ciconia	White Stork	+	+	–	–	–	–	–	–	–	–	–	–	1	WV
ACCIPITRIDAE															
Elanus caeruleus	Blackwinged kite	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Milvus migrans govinda	Pariah Kite	+	+	+	–	+	–	+	+	–	+	+	+	2	Am
Haliastur indus	Brahminy Kite	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Accipiter badius	Shikra	–	–	+	+	+	–	–	+	–	+	–	–	1	R
Accipiter nisus nisosimilis	Sparrow-Hawk	+	–	+	+	+	–	+	+	+	+	+	+	2	R
Buteo rufinus	Longlegged Buzzard	+	–	–	–	–	–	–	–	–	+	–	–	1	Am
Buteo buteo japonicus	Japanese Buzzard	+	–	–	–	–	–	–	–	–	+	–	–	1	Am
Spizaetus cirrhatus cirrhatus	Crested Hawk-Eagle	–	+	+	–	–	–	–	–	–	+	–	–	1	R
Hieraaetus pennatus	Booted Hawk-Eagle	–	+	–	–	–	–	–	–	–	–	–	–	1	Am
Aquila rapax vindhiana	Tawny Eagle	–	+	–	–	–	–	–	–	–	–	–	–	1	Am
Ictinaetus malayensis	Black Eagle	+	+	–	–	–	–	–	–	–	–	–	–	1	Am
Ichthyophaga ichthyaetus	Greyheaded Fishing Eagle	+	+	–	+	+	–	+	+	+	+	+	+	1	A
Sarcogyps calvus	Black or King Vulture	–	+	–	–	–	–	–	–	–	–	–	–	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Neophron percnopterus	Egyptian or Scavenger Vulture	+	+	–	–	–	–	–	–	–	+	–	–	1	Am
Spilornis cheela	Crested serpent Eagle	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Pandion haliaetus	Osprey	+	–	–	–	–	–	–	–	–	–	–	–	1	WV
FALCONIDAE															
Falco biarmicus jugger	Laggar Falcon	–	+	–	–	–	–	–	–	–	–	+	–	1	R
PHASIANIDAE															
Francolinus pondicerianus	Grey Partridge	–	–	–	–	–	–	–	+	–	–	–	–	1	R
Galloperdix spadicea	Red Spurfowl	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Galloperdix lunulata	Painted Spurfowl	+	+	–	–	–	–	–	–	–	–	–	–	1	R
PHASIANIDAE															
Gallus sonneratii	Grey or Sonnerat's Junglefowl	+	+	+	+	+	+	+	+	+	+	+	+	2	R
TURNICIDAE															
Turnix sylvatica	Little Bustard Quail	–	–	–	–	+	+	–	–	–	–	–	–	1	UK
Turnix suscitator	Common Bustard Quail	–	–	–	+	+	+	+	+	–	+	–	+	1	R
RALLIDAE															
Amaurornis phoenicurus	Whitebreasted Waterhen	+	+	–	–	–	–	–	–	–	+	+	+	1	WV
CHARADRIIDAE															
Vanellus indicus	Redwattled Lapwing	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Vanellus malabaricus	Yellowwattled Lapwing	–	–	–	+	+	+	+	–	–	+	–	–	1	SV
Charadrius dubius	Little Ringed Plover	+	–	–	–	–	–	–	–	–	–	–	–	1	WV
Tringa hypoleucos	Common Sandpiper	+	+	+	–	–	–	–	–	–	+	+	+	1	WV
Gallinago stenura	Pintail Snipe	–	–	+	–	–	–	–	–	–	+	–	–	1	WV
COLUMBIDAE															
Treron pompadora	Pompadour or Greyfronted Green Pigeon	+	+	–	–	–	–	–	+	+	+	+	+	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Treron phoenicoptera	Yellowlegged Green Pigeon	+	–	–	–	–	–	–	–	–	–	–	–	1	Am
Columba livia	Blue Rock Pigeon	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Streptopelia decaocto	Indian Ringed Dove	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Streptopelia chinensis	Spotted Dove	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Streptopelia senegalensis	Little Brown or Senegal Dove	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Chalcophaps indica	Emerald or Bronze-winged Dove	+	+	+	+	+	+	+	+	+	+	+	+	1	R
PSITTACIDAE															
Psittacula krameri	Roseringed Parakeet	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Psittacula cyanocephala	Blossomheaded Parakeet	+	+	+	+	–	–	+	+	+	+	+	+	1	Am
Loriculus vernalis	Indian Lorikeet	+	–	–	–	–	–	–	–	–	+	–	–	1	WV
CUCULIDAE															
Clamator coromandus	Redwinged Crested Cuckoo	–	+	–	–	–	–	–	–	–	–	–	+	1	WV
Clamator jacobinus	Pied Crested Cuckoo	+	+	–	–	–	–	–	–	–	–	–	+	1	WV
Cuculus sparverioides	Large Hawk-Cuckoo	–	+	–	–	–	–	–	–	–	–	–	–	1	WV
Cuculus varius	Common Hawk-Cuckoo or Brain-fever Bird	–	+	–	–	–	–	–	–	–	–	–	–	1	WV
Cuculus micropterus	Indian Cuckoo	+	+	–	–	–	–	–	–	–	–	+	+	1	WV
Cacomantis passerinus	Indian Plaintive Cuckoo	+	+	–	–	–	–	–	–	–	–	+	+	1	WV
Eudynamys scolopacea	Koel	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Rhopodytes viridirostris	Small Green-billed Malkoha	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Taccocua leschenaultii	Sirkeer Cuckoo	+	–	–	+	+	+	–	+	–	+	–	–	1	UK
Centropus sinensis	Crow-Pheasant or Coucal	+	+	+	+	+	+	+	+	+	+	+	+	1	R
STRIGIDAE															
Otus bakkamoena	Collared Scops Owl	+	+	–	+	+	+	–	+	+	+	+	+	1	R

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen												Abundance rating	Migratory status
		J	F	M	A	M	J	J	A	S	O	N	D		
Bubo bubo	Eagle-Owl or Great Horned Owl	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Bubo zeylonensis	Brown Fish Owl	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Ninox scutulata	Brown Hawk Owl	–	–	–	–	–	–	–	–	–	+	–	–	1	UK
Athene brama	Spotted Owlet	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Glaucidium radiatum	Jungle Owlet	+	+	+	+	+	+	–	+	+	+	+	+	1	R
CAPRIMULGIDAE															
Caprimulgus macrurus	Longtailed Nightjar	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Caprimulgus asiaticus	Common Indian Nightjar	+	+	–	–	–	–	–	–	–	–	–	–	1	UK
APODIDAE															
Apus melba	Alpine Swift	+	+	+	+	+	+	+	+	+	+	+	+	2	Am
Apus affinis	House Swift	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Cypsiurus parvus	Palm Swift	–	–	+	+	–	+	+	+	+	–	–	–	1	R
ALCEDINIDAE															
Ceryle rudis	Lesser Pied Kingfisher	+	+	–	+	–	–	–	–	–	–	–	–	1	Am
Alcedo atthis	Common Kingfisher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Pelargopsis capensis	Storkbilled Kingfisher	+	+	+	+	+	+	–	+	+	+	+	+	1	R
Halcyon smyrnensis	Whitebreasted Kingfisher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Halcyon pileata	Blackcapped Kingfisher	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
MEROPIDAE															
Merops leschenaulti	Chestnutheaded Bee-Eater	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Merops orientalis	Green Bee-Eater	+	+	+	+	+	+	+	+	+	+	+	+	2	R
CORACIIDAE															
Coracias benghalensis	Indian Roller	+	+	+	–	–	+	+	+	+	+	+	+	1	R
UPUPIDAE															
Upupa epops	Hoopoe	–	–	–	–	+	+	+	+	–	–	–	–	1	SV
BUCEROTIDAE															
Tockus griseus	Malabar Grey Hornbill	–	–	+	–	–	–	–	+	+	+	+	+	1	Am
Buceros bicornis	Great Pied Hornbill	–	–	–	–	+	–	–	–	–	–	–	–	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Treron phoenicoptera	Yellowlegged Green Pigeon	+	–	–	–	–	–	–	–	–	–	–	–	1	Am
Columba livia	Blue Rock Pigeon	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Streptopelia decaocto	Indian Ringed Dove	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Streptopelia chinensis	Spotted Dove	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Streptopelia senegalensis	Little Brown or Senegal Dove	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Chalcophaps indica	Emerald or Bronze-winged Dove	+	+	+	+	+	+	+	+	+	+	+	+	1	R
PSITTACIDAE															
Psittacula krameri	Roseringed Parakeet	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Psittacula cyanocephala	Blossomheaded Parakeet	+	+	+	+	–	–	+	+	+	+	+	+	1	Am
Loriculus vernalis	Indian Lorikeet	+	–	–	–	–	–	–	–	–	+	–	–	1	WV
CUCULIDAE															
Clamator coromandus	Redwinged Crested Cuckoo	–	+	–	–	–	–	–	–	–	–	–	+	1	WV
Clamator jacobinus	Pied Crested Cuckoo	+	+	–	–	–	–	–	–	–	–	–	+	1	WV
Cuculus sparverioides	Large Hawk-Cuckoo	–	+	–	–	–	–	–	–	–	–	–	–	1	WV
Cuculus varius	Common Hawk-Cuckoo or Brain-fever Bird	–	+	–	–	–	–	–	–	–	–	–	–	1	WV
Cuculus micropterus	Indian Cuckoo	+	+	–	–	–	–	–	–	–	–	+	+	1	WV
Cacomantis passerinus	Indian Plaintive Cuckoo	+	+	–	–	–	–	–	–	–	–	+	+	1	WV
Eudynamys scolopacea	Koel	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Rhopodytes viridirostris	Small Green-billed Malkoha	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Taccocua leschenaultii	Sirkeer Cuckoo	+	–	–	+	+	+	–	+	–	+	–	–	1	UK
Centropus sinensis	Crow-Pheasant or Coucal	+	+	+	+	+	+	+	+	+	+	+	+	1	R
STRIGIDAE															
Otus bakkamoena	Collared Scops Owl	+	+	–	+	+	+	–	+	+	+	+	+	1	R

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Bubo bubo	Eagle-Owl or Great Horned Owl	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Bubo zeylonensis	Brown Fish Owl	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Ninox scutulata	Brown Hawk Owl	–	–	–	–	–	–	–	–	–	+	–	–	1	UK
Athene brama	Spotted Owlet	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Glaucidium radiatum	Jungle Owlet	+	+	+	+	+	+	–	+	+	+	+	+	1	R
CAPRIMULGIDAE															
Caprimulgus macrurus	Longtailed Nightjar	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Caprimulgus asiaticus	Common Indian Nightjar	+	+	–	–	–	–	–	–	–	–	–	–	1	UK
APODIDAE															
Apus melba	Alpine Swift	+	+	+	+	+	+	+	+	+	+	+	+	2	Am
Apus affinis	House Swift	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Cypsiurus parvus	Palm Swift	–	–	+	+	–	+	+	+	+	–	–	–	1	R
ALCEDINIDAE															
Ceryle rudis	Lesser Pied Kingfisher	+	+	–	+	–	–	–	–	–	–	–	–	1	Am
Alcedo atthis	Common Kingfisher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Pelargopsis capensis	Storkbilled Kingfisher	+	+	+	+	+	+	–	+	+	+	+	+	1	R
Halcyon smyrnensis	Whitebreasted Kingfisher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Halcyon pileata	Blackcapped Kingfisher	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
MEROPIDAE															
Merops leschenaulti	Chestnutheaded Bee-Eater	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Merops orientalis	Green Bee-Eater	+	+	+	+	+	+	+	+	+	+	+	+	2	R
CORACIIDAE															
Coracias benghalensis	Indian Roller	+	+	+	–	–	+	+	+	+	+	+	+	1	R
UPUPIDAE															
Upupa epops	Hoopoe	–	–	–	–	+	+	+	+	–	–	–	–	1	SV
BUCEROTIDAE															
Tockus griseus	Malabar Grey Hornbill	–	–	+	–	–	–	–	+	+	+	+	+	1	Am
Buceros bicornis	Great Pied Hornbill	–	–	–	–	+	–	–	–	–	–	–	–	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen												Abundance rating	Migratory status
		J	F	M	A	M	J	J	A	S	O	N	D		
CAPITONIDAE															
Megalaima zeylanica	Large Green Barbet	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Megalaima viridis	Small Green Barbet	–	+	–	–	–	–	–	–	–	–	–	–	1	UK
Megalaima haemacephala	Crimsonbreasted Barbet or Coppersmith	+	+	+	–	–	–	+	+	–	–	–	+	1	R
PICIDAE															
Dinopium benghalense	Lesser Goldenbacked Woodpecker	+	+	+	+	+	+	+	+	–	+	+	+	1	R
Dinopium javanense	Indian Golden-backed Three-toed Woodpecker	–	+		–	+	–	–	–	+	+	+	–	1	Am
PITTIDAE															
Pitta brachyura	Indian Pitta	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
ALAUDIDAE															
Mirafra javanica	Singing Bush Lark	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Mirafra erythroptera	Redwinged Bush Lark	+	+	+	+	+	+	+	+	+	+	+	+	2	R
HIRUNDINIDAE															
Hirundo daurica	Striated or Red-rumped Swallow	+	+	–	–	–	–	–	–	–	–	–	–	1	UK
Delichon urbica	House Martin	+	+	–	–	–	–	–	–	–	+	+	+	1	UK
LANIIDAE															
Lanius excubitor	Grey Shrike	+	+	–	–	–	–	–	–	+	+	+	+	1	Am
Lanius vittatus	Baybacked Shrike	–	+	–	–	–	–	–	–	–	+	–	–	1	Am
Lanius cristatus	Brown Shrike	+	+	+	–	–	–	–	–	+	+	+	+	2	R
ORIOLIDAE															
Oriolus oriolus	Golden Oriole	+	+	+	+	–	–	–	–	+	+	+	+	1	Am
DICRURIDAE															
Dicrurus adsimilis	Black Drongo or King-Crow	+	+	+	–	–	–	–	–	–	+	+	+		
Dicrurus leucophaeus	Grey or Ashy Drongo	+	+	+	+	–	–	–	–	–	+	+	+	1	Am
Dicrurus caerulescens	Whitebellied Drongo	+	+	+	+	–	–	–	–	+	+	+	+	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
ARTAMIDAE															
Artamus fuscus	Ashy Swallow-Shrike	+	+	+	+	+	+	+	+	+	+	+	+	1	R
STURNIDAE															
Sturnus malabaricus	Greyheaded Myna	+	–	–	–	–	–	–	–	–	–	+	–	1	WV
Sturnus pagodarum	Blackheaded or Brahminy Myna	–	+	–	–	–	–	–	–	–	–	–	–	1	WV
Acridotheres tristis	Common Myna	+	+	+	+	+	+	+	+	+	+	+	+	3	R
CORVIDAE															
Dendrocitta vagabunda	Indian Tree Pie	+	–	–	–	–	–	–	–	–	–	–	–	1	UK
Corvus splendens	House Crow	+	+	+	+	+	+	+	+	+	+	+	+	3	Am
Corvus macrorhynchos	Jungle Crow	+	+	+	+	+	+	+	+	+	+	+	+	3	R
CAMPEPHAGIDAE															
Tephrodornis pondicerianus	Common Wood Shrike	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Coracina novaehollandiae	Large Cuckoo Shrike	–	–	+	–	–	–	–	–	–	–	–	–	1	Am
Coracina melanoptera	Blackheaded Cuckoo Shrike	+	+	+	+	–	–	–	–	–	+	+	+	1	WV
Pericrocotus flammeus	Scarlet Minivet	+	–	+	–	–	+	–	–	+	+	–	+	1	Am
Pericrocotus cinnamomeus	Small Minivet	+	+	+	+	+	+	+	+	+	+	+	+	2	R
IRENIDAE															
Aegithina tiphia	Common Iora	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Chloropsis cochinchinensis	Goldmantled Chloropsis or Leaf Bird	+	+	+	+	+	+	+	+	+	+	+	+	2	R
PYCNONOTIDAE															
Pycnonotus melanicterus gularis	Rubythroated Yellow Bulbul	+	+	+	+	+	+	+	–	+	+	+	+	1	R
Pycnonotus jocosus	Redwhiskered Bulbul	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Pycnonotus cafer	Redvented Bulbul	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Pycnonotus luteolus	Whitebrowed Bulbul	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Hypsipetes indicus	Yellowbrowed Bulbul	+	–	–	–	+	–	–	–	–	–	+	+	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Capitonidae															
Megalaima zeylanica	Large Green Barbet	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Megalaima viridis	Small Green Barbet	–	+	–	–	–	–	–	–	–	–	–	–	1	UK
Megalaima haemacephala	Crimsonbreasted Barbet or Coppersmith	+	+	+	–	–	–	+	+	–	–	–	+	1	R
Picidae															
Dinopium benghalense	Lesser Goldenbacked Woodpecker	+	+	+	+	+	+	+	+	–	+	+	+	1	R
Dinopium javanense	Indian Goldenbacked Three-toed Woodpecker	–	+		–	+	–	–	–	+	+	+	–	I	Am
Pittidae															
Pitta brachyura	Indian Pitta	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Alaudidae															
Mirafra javanica	Singing Bush Lark	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Mirafra erythroptera	Redwinged Bush Lark	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Hirundinidae															
Hirundo daurica	Striated or Red-rumped Swallow	+	+	–	–	–	–	–	–	–	–	–	–	1	UK
Delichon urbica	House Martin	+	+	–	–	–	–	–	–	–	+	+	+	1	UK
Laniidae															
Lanius excubitor	Grey Shrike	+	+	–	–	–	–	–	–	+	+	+	+	1	Am
Lanius vittatus	Baybacked Shrike	–	+	–	–	–	–	–	–	–	+	–	–	1	Am
Lanius cristatus	Brown Shrike	+	+	+	–	–	–	–	–	+	+	+	+	2	R
Oriolidae															
Oriolus oriolus	Golden Oriole	+	+	+	+	–	–	–	–	+	+	+	+	1	Am
Dicruridae															
Dicrurus adsimilis	Black Drongo or King-Crow	+	+	+	–	–	–	–	–	–	+	+	+		
Dicrurus leucophaeus	Grey or Ashy Drongo	+	+	+	+	–	–	–	–	–	+	+	+	I	Am
Dicrurus caerulescens	Whitebellied Drongo	+	+	+	+	–	–	–	–	+	+	+	+	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Artamidae															
Artamus fuscus	Ashy Swallow-Shrike	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Sturnidae															
Sturnus malabaricus	Greyheaded Myna	+	–	–	–	–	–	–	–	–	–	+	–	1	WV
Sturnus pagodarum	Blackheaded or Brahminy Myna	–	+	–	–	–	–	–	–	–	–	–	–	1	WV
Acridotheres tristis	Common Myna	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Corvidae															
Dendrocitta vagabunda	Indian Tree Pie	+	–	–	–	–	–	–	–	–	–	–	–	1	UK
Corvus splendens	House Crow	+	+	+	+	+	+	+	+	+	+	+	+	3	Am
Corvus macrorhynchos	Jungle Crow	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Campephagidae															
Tephrodornis pondicerianus	Common Wood Shrike	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Coracina novaehollandiae	Large Cuckoo Shrike	–	–	+	–	–	–	–	–	–	–	–	–	1	Am
Coracina melonoptera	Blackheaded Cuckoo Shrike	+	+	+	+	–	–	–	–	–	+	+	+	1	WV
Pericrocotus flammeus	Scarlet Minivet	+	–	+	–	–	+	–	–	+	+	–	+	1	Am
Pericrocotus cinnamomeus	Small Minivet	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Irenidae															
Aegithina tiphia	Common Iora	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Chloropsis cochinchinensis	Goldmantled Chloropsis or Leaf Bird	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Pycnonotidae															
Pycnonotus melanicterus gularis	Rubythroated Yellow Bulbul	+	+	+	+	+	+	+	–	+	+	+	+	1	R
Pycnonotus jocosus	Redwhiskered Bulbul	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Pycnonotus cafer	Redvented Bulbul	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Pycnonotus luteolus	Whitebrowed Bulbul	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Hypsipetes indicus	Yellowbrowed Bulbul	+	–	–	–	+	–	–	–	–	–	+	+	1	Am

TABLE 1 (contd.)

Family and scientific name	Common English name	Months during which birds were seen												Abundance rating	Migratory status
		J	F	M	A	M	J	J	A	S	O	N	D		
Hypsipetes madagascariensis	Black Bulbul	–	+	–	–	+	+	+	–	–	–	–	–	1	Am
MUSCICAPIDAE															
Pellorneum ruficeps	Spotted Babbler	+	+	–	–	–	–	–	–	+	–	+	+	1	WV
Dumetia hyperythra	Rufousbellied Babbler	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Chrysomma sinense	Yelloweyed Babbler	+	+	+	+	+	–	+	–	+	+	+	+	1	R
Turdoides striatus	Jungle Babbler	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Turdoides affinis	Whiteheaded Babbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Muscicapa muttui	Brownbreasted Flycatcher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Muscicapa parva	Redbreasted Flycatcher	+	+	+	–	–	–	–	–	–	+	+	+	1	WV
Muscicapa pallipes	Whitebellied Blue Flycatcher	–	–	–	–	–	–	–	–	–	+	+	–	1	WV
Muscicapa tickelliae	Tickell's Blue Flycatcher	+	+	+	–	–	–	–	–	–	+	+	+	1	WV
Terpsiphone paradisi	Paradise Flycatcher	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Hypothymis azurea	Blacknaped Flycatcher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Prinia hodgsonii	Franklin's Wren-Warbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Prinia sylvatica	Jungle Wren-Warbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
MUSCICAPIDAE (contd.)															
Orthotomus sutorius	Tailor Bird	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Acrocephalus aedon	Thick billed Warbler	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Acrocephalus dumetorum	Blyth's Reed Warbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Hippolais caligata	Booted Warbler	+	–	–	–	–	–	+	+	+	+	+	+	1	R
Sylvia hortensis	Orphean Warbler	+	+	+	–	–	–	–	–	–	–	+	+	1	WV
Phylloscopus magnirostris	Largebilled Leaf Warbler	+	+	+	–	–	–	–	–	+	+	+	+	1	WV

Family and scientific name	Common English name	Months during which birds were seen												Abundance rating	Migratory status
		J	F	M	A	M	J	J	A	S	O	N	D		
Phylloscopus trochiloides	Dull Green Leaf Warbler	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Brachypteryx major	Rufousbellied Shortwing	+	+	+	–	–	–	–	–	–	–	–	–	1	UK
Copsychus saularis	Magpie-Robin or Dhyal	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Phoenicurus ochruros phoenicuroides	Black Redstart	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Saxicoloides fulicata	Indian Robin	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Monticola solitarius	Blue Rock Thrush	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Zoothera citrina	Orangeheaded Ground Thrush	–	–	–	–	–	–	–	–	–	+	–	–	1	WV
SITTIDAE															
Sitta frontalis	Velvetfronted Nuthatch	–	–	–	–	–	–	–	–	+	+	–	–	1	Am
MOTACILLIDAE															
Anthus novaeseelandiae	Paddyfield Pipit	–	+	+	+	+	+	+	–	+	+	+	–		R
Motacilla indica	Forest Wagtail	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Motacilla cinerea	Grey Wagtail	+	+	+	+	–	–	–	–	+	+	+	+	1	WV
Motacilla maderaspatensis	Large Pied Wagtail	+	+	+	+	+	+	+	+	+	+	+	+	2	R
DICAEIDAE															
Dicaeum erythrorhynchos	Tickell's Flowerpecker	+	+	+	+	+	+	+	+	+	+	+	+	2	R
NECTARINIIDAE															
Nectarinia zeylonica	Purplerumped Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Nectarinia minima	Small Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Nectarinia lotenia	Loten's Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Nectarinia asiatica	Purple Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	1	R
PLOCEIDAE															
Passer domesticus	House Sparrow	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Lonchura malabarica	Whitethroated Munia	+	+	–	–	–	–	–	–	–	–	–	–	1	Am
Lonchura striata	Whitebacked Munia	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Lonchura malacca	Blackheaded Munia	+	+	+	+	+	+	+	+	+	+	+	+	1	R

Key : Abundance rating : 1–rare, 2–frequently seen, 3–common.
Migratory status : R–resident, WV–winter visitor, Am–Altitudinal migrant, UK–unknown.

TABLE 1 (contd.)

Family and scientific name	Common English name	J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Hypsipetes madagascariensis	Black Bulbul	–	+	–	–	+	+	+	–	–	–	–	–	1	Am
MUSCICAPIDAE															
Pellorneum ruficeps	Spotted Babbler	+	+	–	–	–	–	–	–	+	–	+	+	1	WV
Dumetia hyperythra	Rufousbellied Babbler	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Chrysomma sinense	Yelloweyed Babbler	+	+	+	+	+	–	+	–	+	+	+	+	1	R
Turdoides striatus	Jungle Babbler	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Turdoides affinis	Whiteheaded Babbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Muscicapa muttui	Brownbreasted Flycatcher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Muscicapa parva	Redbreasted Flycatcher	+	+	+	–	–	–	–	–	–	+	+	+	1	WV
Muscicapa pallipes	Whitebellied Blue Flycatcher	–	–	–	–	–	–	–	–	–	+	+	–	1	WV
Muscicapa tickelliae	Tickell's Blue Flycatcher	+	+	+	–	–	–	–	–	–	+	+	+	1	WV
Terpsiphone paradisi	Paradise Flycatcher	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Hypothymis azurea	Blacknaped Flycatcher	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Prinia hodgsonii	Franklin's Wren-Warbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Prinia sylvatica	Jungle Wren-Warbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
MUSCICAPIDAE (contd.)	.														
Orthotomus sutorius	Tailor Bird	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Acrocephalus aedon	Thick billed Warbler	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Acrocephalus dumetorum	Blyth's Reed Warbler	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Hippolais caligata	Booted Warbler	+	–	–	–	–	–	+	+	+	+	+	+	1	R
Sylvia hortensis	Orphean Warbler	+	+	+	–	–	–	–	–	–	–	+	+	1	WV
Phylloscopus magnirostris	Largebilled Leaf Warbler	+	+	+	–	–	–	–	–	+	+	+	+	1	WV

Family and scientific name	Common English name	J	F	M	A	M	J	J	A	S	O	N	D	Abundance rating	Migratory status
Phylloscopus trochiloides	Dull Green Leaf Warbler	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Brachypteryx major	Rufousbellied Shortwing	+	+	+	–	–	–	–	–	–	–	–	–	1	UK
Copsychus saularis	Magpie-Robin or Dhyal	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Phoenicurus ochruros phoenicuroides	Black Redstart	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Saxicoloides fulicata	Indian Robin	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Monticola solitarius	Blue Rock Thrush	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Zoothera citrina	Orangeheaded Ground Thrush	–	–	–	–	–	–	–	–	–	+	–	–	1	WV
SITTIDAE															
Sitta frontalis	Velvetfronted Nuthatch	–	–	–	–	–	–	–	–	+	+	–	–	1	Am
MOTACILLIDAE															
Anthus novaeseelandiae	Paddyfield Pipit	–	+	+	+	+	+	+	–	+	+	+	–		R
Motacilla indica	Forest Wagtail	+	+	+	–	–	–	–	–	+	+	+	+	1	WV
Motacilla cinerea	Grey Wagtail	+	+	+	+	–	–	–	–	+	+	+	+	1	WV
Motacilla maderaspatensis	Large Pied Wagtail	+	+	+	+	+	+	+	+	+	+	+	+	2	R
DICAEIDAE															
Dicaeum erythrorhynchos	Tickell's Flowerpecker	+	+	+	+	+	+	+	+	+	+	+	+	2	R
NECTARINIIDAE															
Nectarinia zeylonica	Purplerumped Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	3	R
Nectarinia minima	Small Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Nectarinia lotenia	Loten's Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Nectarinia asiatica	Purple Sunbird	+	+	+	+	+	+	+	+	+	+	+	+	1	R
PLOCEIDAE															
Passer domesticus	House Sparrow	+	+	+	+	+	+	+	+	+	+	+	+	1	R
Lonchura malabarica	Whitethroated Munia	+	+	–	–	–	–	–	–	–	–	–	–	1	Am
Lonchura striata	Whitebacked Munia	+	+	+	+	+	+	+	+	+	+	+	+	2	R
Lonchura malacca	Blackheaded Munia	+	+	+	+	+	+	+	+	+	+	+	+	1	R

Key: Abundance rating: 1–rare, 2–frequently seen, 3–common.
Migratory status: R–resident, WV–winter visitor, Am–Altitudinal migrant, UK–unknown.

upper slopes than on the plateau. Similarly Yellowthroated Sparrow (*Petronia xanthocollis*) was frequently seen below lower Papanasam reservoir which has got more open areas, cultivation and human habitation. Bluetailed Beeeater (*Merops philippinus*) was seen once below lower Pabanasam reservoir.

There was an observation of a Grey junglefowl female having a nest with five eggs on an *Albizzia lebbeck* tree which had a tangled growth of *Zizyphus oenoplia.* The nest was five metres from the ground, bigger than a crow's nest and had in addition to twigs, bits of rag and paper. Once a Sparrow Hawk sat close to the nest and the hen, which was preening perched on a nearby branch, charged at the hawk and chased it away. A few days later neither the hen nor the eggs were found in the nest. Our observation seems to be the first record of Grey Junglefowl nesting on trees.

There were some interesting interactions between primates and birds. Once a Brahminy kite was seen in its nest on a *Hopea parviflora* tree and three subadults of a seven-member Nilgiri langur (*Presbytis johnii*) troop were seen disturbing the bird by shaking and jumping on to the branch where the kite had its nest. In response, both the male and female kites chased the langurs by diving towards them. This observed behaviour of langurs and the reaction of kites was on four mornings.

Another time an immature Brahminy Kite was seen repeatedly diving at an adult ♂ Nilgiri langur which was feeding on the top of a tree. In response the langur sometimes ducked its head or threw out its arm as if to block or hit the bird.

Once a bonnet macaque (*Macaca radiata*) was seen chasing and almost catching a Koel. When this happened five Koels (2 ♂♂ and 3 ♀♀) were feeding on *Ficus tsiela* fruits. A troop of bonnet macaques suddenly raided the tree and started chasing the Koels. During this melée one ♂ Koel, while being chased by a subadult bonnet, jumped on to another branch where a ♀ bonnet was feeding. This bonnet almost caught the Koel which struggled, screamed and flew away with loud alarm calls. A similar incident was seen when a *Ficus bengalensis* tree was in fruit.

Twice bonnet macaques were seen raiding the nest of a jungle crow in two different seasons but on the same *Terminalia belerica* tree. Once the crow was seen in the nest but it was chased away by the bonnet macaques, and the fact that the crow did not return the next day would imply the egg/eggs may have been damaged or eaten by the bonnet.

Several times we have also observed drongos and fly catchers following giant squirrels (*Ratufa indica*), bonnet macaques and Nilgiri langur in the canopy and catching insects flushed by these mammals. This association is worth investigating further.

Our preliminary observations at Mundanthurai show that this place has great potential for further ornithological field research, especially to understand the impact of reservoir construction, power-line formations, monoculture plantations, and unabated and increasing incidence of fire wood cutting on bird species. We hope that this paper would lead to more long term bird studies in this fascinating area.

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POSSIBILITIES OF SELF-SUSTENANCE OF FREE RANGING RHESUS OF TUGHLAQABAD[1]

IQBAL MALIK[2]

(*With a text-figure*)

INTRODUCTION

Two decades ago, the estimated number of rhesus macaques in the wild was around 4,000,000 but, according to the latest estimate it has been reduced to only about 140,000 individuals. The reasons for the decline of free-ranging Rhesus population could be (1) change in the habitat, (2) no scope of expansion of habitat, (3) lack of abundance of food and protection, and (4) trapping.

During a long term study of free-ranging Rhesus population of Tughlaqabad, it was observed that complete protection, no trapping, abundance of food, favourable adaptation to the environment and habitat which has scope for expansion made the self sustenance of an ever growing population possible. At Tughlaqabad, a positive correlation was witnessed in the population growth and the potentialities of the habitat. The data provides important guidelines for conservation and restoration of primate population and an encouraging example of primate population improvement in a generally discouraging worldwide situation.

STUDY AREA

Tughlaqabad is an ancient city site and 14th Century fort situated on the southern edge of New Delhi at 30° 25′ N latitude and 78° 76′ E longitude. The home range of the rhesus monkey groups under study extends throughout the fort and surrounding areas, covering approximately 5 sq. km. (2.5 × 2.0 km.). The fort was built of massive stones on a rocky hill with the outer ramparts integrated into the hill, so that the entire structure rises 50-90 feet above the surrounding plain (Fig. 1). The outer walls of the fort form a polygon with a circumference of nearly 5 km. The flat and fertile area surrounding the fort contains cropland, pasture, two forested areas,

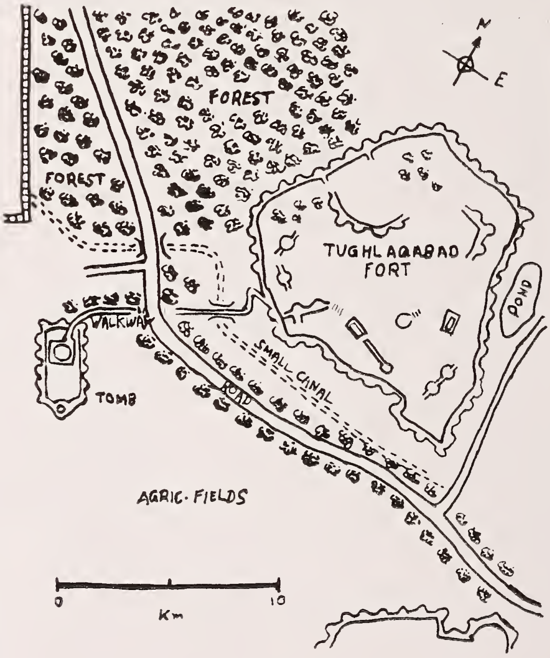

Fig. 1. Home range of Tughlaqabad monkeys showing Tughlaqabad fort, tomb, forest, plantations, agricultural fields, canal, hills, and surrounding roads.

[1] Accepted November 1985.

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and encroaching suburban development. A road runs through the southern part of the area; trees lining the area are used by the rhesus monkeys for sleeping at night and resting during the day. Across the road, to the south of the fort, is the restored tomb of Tughlaq Shah, who died in 1325 A.D. The entire area, both the fort and the tomb, has considerable historical significance and has been described by Williams (1962) .... "The vast size, strength, and visible solidity on the whole give to Tughlaqabad an air of stern and massive grandeur."

The fort constitutes one-fourth of the total area, two forest plantations occupy another one-fourth, and the surrounding open areas of cultivation and pasture constitute the remaining half (Fig. 1).

Tughlaqabad has a subtropical climate with marked seasonal changes. During the months of May and June, daytime temperatures often reach 40° to 45°C; in December and January temperatures fall to 7° to 9°C. Monsoon occurs from the end of June or early July until mid-September, with an annual average of 567 mm. of rain. Winter and spring rains occur sporadically and are usually light.

The natural vegetation inside the fort is xerophytic, generally grasses and arid forbs and shrubs. Outside the fort, vegetation is more mesophytic, and better ground water supports trees and crops, primarily wheat and pulses. The main trees present are Indian jujube (*Zizyphus jujuba*), neem or margosa (*Azadirachta indica*), sheesham or sissoo (*Dalbergia sissoo*), oak (*Quercus incana*), acacia (*Acacia arabica*), pipal (*Ficus religiosa*) and date palm (*Phoenix dactylifera*). Other than people, the dominant fauna includes rhesus monkeys, cattle, donkeys, goats, dogs, jackals, mongoose, lizards, and a great variety of birds, both migratory and resident. Peafowl, partridges, pigeons, crows, sparrows, vultures, mynas, and kites are common.

FIELD METHODS

The present study started in 1980 to study selected behavioural aspects of Rhesus of the area, with an emphasis on population dynamics. Related counts (Malik, Seth, Southwick 1984) were made in (1) March before the birth season, (2) July and August immediately after the birth season, (3) October and November following monsoon and just prior to winter. This method provided data on the minimum March, maximum July and August population of the year and a transitional period from monsoon to winter (October and November). A record of births, deaths, disappearances, accidents and injuries was also kept. Hence when the largest group of the area increased its home range and then changed its core area, it was immediately noted, and thereafter a constant watch was kept to observe the movements of this particular group. Observations have been made from March, 1980 to January, 1985.

RESULTS

Diversity of habitat:

The Tughlaqabad area provides the monkeys with a wide range of food, both natural and that offered by humans. Food is consistently provided by humans, in an almost ritualistic way. On days when humans do not provide enough food, the monkeys have the natural vegetation and crops grown by humans to fall back on. The monkeys need never go hungry and, as a result, they are healthy and well-fed.

The fact that the monkeys spend 80% of their waking hours on the ground, provides proof of the suitability of the area as well as of the positive relationship that exists between the Rhesus monkeys and humans. In stormy weather, when the banging of the branches and the howling of the wind heighten their sense of insecurity, the monkeys take refuge in the thick, crevice-ridden walls of the fort. When attacked by other animals (dogs, cattle, etc.), they seek sanctuary in nearby trees. The open spaces in the fort provide them with enough space to sun-bathe during the winter. The people of the area have always treated the monkeys with reverence, so that they are not harassed; on the contrary, they are provided with protection.

No trapping was done during the course of this study, though, as I learned from local residents, trapping went on until 1978. The monkey population fell to quite a low level and due to these circumstances, the monkeys became quite aggressive towards human beings. Now there is peaceful co-existence between man and Rhesus at Tughlaqabad.

Elasticity of habitat:

From March, 1980 to November, 1984 the home range of rhesus monkey groups under study extended throughout the fort and surrounding areas covering approximately 5 sq. km.

In 1984, after the breeding (May-July) but before the onset of winter, group A extended its home range. Adjoining the southern end of their initial home range, is situated a walled Air Force enclosure. This establishment — a completely restricted area — was included in the home range (Fig. 1).

Group A first started frequenting it, then used it for sleeping and resting, and then most of their time was spent inside this Air Force compound which is now their core area. The canteen inside this area seems to meet a major portion of their diet. At times they come out to feed at the roadside but it is never quite certain that the whole group would converge upon the visitor as they did earlier. The rhesus have been seen on the northern wall of this compound and, at times, on the eastern and western walls but never on the southern side. The extent of utilisation of this space is not exactly known, but a vague estimate is that the extended home range of group A is 1 km^2.

The vegetation of the Air Force area is similar to that on the outside, but cultivation is minimal, being limited to kitchen gardens which would be zealously guarded against raids by the rhesus. Trees visible from the outside are sheesham or Sissoo (*Dalbergia sissoo*) and neem or margosa (*Azadirachta indica*). It would, however, be safe to presume that there would be other varieties of trees, some of which may even be bearing fruits consumed by human beings. The fauna would slightly vary from the outside as dogs, goats, donkeys, buffaloes and cattle would not be allowed inside. As for smaller animals like mongoose, lizards, and snakes such restrictions would be difficult to impose. The variety of birds would also be similar to the outside.

The habitat provides a vast scope for the further expansion of the home range of rhesus of the area (Fig. 1). On the southeast side of their territory is 'Adilabad'. This is another fort but considerably smaller than the one presently used by the rhesus, but providing similar facilities for them. To date the monkeys have only visited the boundaries of this fort for water, but may be in future, if need be, they might start spending more of their time there. Further south are rocky hills with xerophytic vegetation with little or no predators. Towards the north, beyond the fort are patches of forest with a busy road running along them, which could be an excellent source of food for them. Towards the east, beyond the home range are more forests, which can provide good cover if the need arises. Rhesus have so far not visited these areas.

Population growth and habitat:

In five years the rhesus population at Tughlaqabad has increased by 119.38%, from 160 monkeys in July, 1980 to 351 in July, 1984 — an annual average increase of 22.70%. It is felt that this tremendous increase is due to the habitat, which provides protection, abundance of food and water, good cover and has scope for expansion. Due to the right combination of ecological and behavioural factors, rhesus not only sustained themselves but the population more than doubled in five years.

In 1980, the number of Rhesus per sq. kilometre of home range was 32. With the increase of population every year, the number per sq. km. kept increasing (Table 1). The maximum number was in July, 1984, viz. 70.2 Rhesus per sq. km. of the home range. This congestion probably led to the expansion of their initial home range, as a result of which, in November, 1984 the number came down to 57.4 monkeys per sq. km. of the area. This was almost the same as in 1983 (57.2 Rhesus per sq. km. of the area). It seems that the maximum number of Rhesus which the initial home range could sustain, is around 286.

TABLE 1

NUMBER OF RHESUS PER SQUARE KILOMETRE OF HOME RANGE JULY 1980-NOV. 1984

Date of census	Total Rhesus population of the area	Home Range (Sq. km.)	No. of Rhesus/ Sq. km.
July 1980	160	5	32
July 1981	201	5	40.2
July 1982	244	5	48.8
July 1983	286	5	57.2
July 1984	351	5	70.2
Nov. 1984	351	6	57.4

Splitting and habitat:

The social behaviour interacting with environmental parameters determines the number of rhesus that may exist in a group. At the beginning of this study in January, 1980, the Tughlaqabad rhesus population consisted of two groups; A of 92 monkeys, and B of 28. By the summer of 1983, the population had grown to 286 monkeys, and the number of groups had increased to five (A, B, C, D and E). Groups C, D and E were splinter groups of A, which remained the largest groups in the area. None of the members of group B joined either C, D or E nor did groups C and D contribute to group E. Group B remained an intact group throughout the study period.

The first split of group A took place in December, 1980, towards the end of the rainy season. The group size was 123 individuals, and a sub-group of 21 separated to become group C. Fifteen months later, in March, 1982, at the beginning of the birth season, the total size of group A was 120, and the second split occurred when 11 individuals left to form group D. Group A was reduced to 109 individuals but, after the birth seasons of 1982 in June, it numbered 133. The third split occurred in the spring of 1983 when group A numbered 137 individuals, of which 29 left to form group E. By July, 1983, group A had been restored to a level of 123 through births and, by July, 1984 its number went up to 155 but no split took place. Table 2 shows the effect of expansion of home range on splitting. In the initial home range, group A apparently could sustain only a certain number of individuals (approximately 120), and still maintain co-ordinated activities as a social unit. Once the number exceeded this limit, a splinter group was formed. The reason for no split in 1984 (when the number was 155) could be the increased home range of group A. In future years a record of popula-

TABLE 2

EFFECTS OF EXPANSION OF HOME RANGE ON SPLITS IN GROUP A.

Date of Census	Home range (sq. km.)	No. of Rhesus of Parent Group	Formation of splintered Ranks from Group A
July 1980	5	123	—
July 1981	5	154	123 — (A) 31 — (C)
July 1982	5	148	133 — (A) 15 — (D)
July 1983	5	152	123 — (A) 29 — (E)
July 1984	5	155	—
Nov. 1984	6	155	—

tion splits of groups can reveal the optimum number of Rhesus which can be sustained in group A in this expanded home range.

There was a clear dominance pattern in intergroup encounters. Group A still remained the most powerful, as well as the largest group, at the termination of this study in January, 1985, as it had been since January, 1980.

DISCUSSION

It has been proposed that, in northern India, one reason for the decline in rhesus population could be the changing beliefs of the rural people who no longer consider them sacred (Seth & Seth 1983). But at Tughlaqabad, people consider them sacred. They are given protection against undue harassment. One instance is of a lorry driver who had accidentally run over a monkey and was given a severe beating. This is perhaps the one instance which would confirm beyond all doubts that the beliefs of the people have not changed. It is felt that it is not the beliefs that are changing but the monetary condition of the people who find it more and more difficult to be generous to the rhesus monkeys. It is still true that humans in large number and from great distances come to feed them.

Another reason could be the changing habitat due to deforestation, overgrazing, commercial development and spread of cities (Seth & Seth 1983). The changes in habitat were also observed at Tughlaqabad. For example, in 1982 a shooting range was constructed on the southern side of the monkeys' territory which resulted in increased human activity. Secondly, the noise of the firing added to the monkeys' sense of insecurity and fear, as a result of which they would go to the fort. The road which runs though the area has an ever increasing traffic. With the increase in tourists and other activities, related facilities have also started cropping up, for instance, tea stalls and vendors. But it was observed that even after the construction of the shooting ranges, the monkeys were still using the same sleeping quarters that they were using prior to construction and they did not decline in numbers in this area. As the monkeys obtain a major portion of their diet from human beings, a preference for a location secluded from human interference [J. E. Fa (1983)] would not be applicable here. Southwick (1967) and Alexander & Roth (1971) observed that aggression in captive groups of rhesus and Japanese macaques respectively increased under crowded conditions. Southwick *et al.* (1965) reported that adult males attacked other members of a group, including infants, at feeding time. R. P. Mukherjee (1976) observed that males of the Mahabali temple attacked group members during feeding and non-feeding times, and even when unprovoked. This was the result of the population having increased, with no scope for expansion of their territory. The aggression may have further increased the mortality.

Brennan and Else (1984), in their study of De Brazza monkeys (*Cercopithecus neglectus*) suggested that the remnant population (just over 100 in Kenya) be translocated as the first step in trying to save them. It is felt that if the present trend of urbanisation in the area continues, the present rate of growth of this population would fall unless they are translocated. A favourable point to be noted here would be the availability of a suitable locality in the same habitat.

I propose several possible reasons for the high population growth and low mortality rates of the Tughlaqabad rhesus. First, the population in this particular locality has been rigorously protected by the beliefs and traditions of local people. Prior to 1978, the protection by local people could not be total because the people remained primarily in their fields and along the roadside, and were not always present when the monkeys went into the forest and fort areas. Beginning in 1978, however, and more or less coincident with the rhesus export ban in April, 1978, the government of India began a programme to attract more tourists to Tughlaqabad, and full-time chowkidars or guards were assigned to the Tughlaqabad fort. These chowkidars provided virtually total protection for the monkeys by preventing anyone from molesting them.

Secondly, there are no predators in the area, except dogs, and the area is so rich in trees, walls and crevices where dogs cannot reach, the monkeys can easily escape from attacks by dogs.

Food resources are abundant. In addition to many natural foods provided by the vegetation of the area, of which more than 43 species were consumed, food provided by humans is so abundant on some days that much of it goes waste. The monkeys thus have three sources of food — natural vegetation, surrounding cropland, and extensive provisioning by people along the roadside and entrances to the fort and tomb.

The home range of the monkeys include two areas of forest plantations, in which good food trees (such as neem, jujube, sheesham, and peepal). are now beginning to reach a stage of growth and size of real benefit to rhesus monkeys. I have the impression that the successional growth of the forest reached a threshold point in the late 1970's and now provides significantly better cover and food for the monkeys. This has considerably enhanced their habitat.

I believe the groups are well adapted to this area. They, therefore, require no period of adaptation or adjustment to capitalize on the new benefits of extra protection and expandable habitat.

I believe that the low level of aggressive behaviour observed indicates both the favourable expandable habitat of the monkeys and their successful adaptation to it. Their peaceful behaviour could certainly be a reason for low mortality.

An additional reason for the outstanding population growth is that the animals were healthy and no obvious diseases were apparent. I did not see any coughing, runny noses, and diarrhoeal symptoms which often appear in other rhesus groups, especially those in and around towns and temples. Finally, at Tughlaqabad it was observed that an increase in the home range makes possible the self sustenance of an ever growing population.

The most dominant group of the area made a pre-emptive move to check any possible decline in their population by first expanding its home range and then changing its core area. Thus a positive correlation was witnessed in the population growth and the potentialities of the habitat at Tughlaqabad.

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FLORISTIC AND ECOLOGICAL STUDIES ON LEGUMES FROM HILLY REGIONS OF PUNE AND SATARA DISTRICTS OF MAHARASHTRA STATE[1]

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INTRODUCTION

Legume bearing plants form the third largest group among the angiosperms, containing about 748 genera and 19,700 species (Allen and Allen 1980). As far as India is concerned, a total number of 145 genera divided in 1083 species (Tiwari 1979) are reported from the subcontinent. In Maharashtra State there are about 88 genera and 380 species (Cooke 1903) of leguminous plants. This large group of economically important plants has been studied from various angles in all parts of our country. A study of the available literature on the flora of Western Maharashtra (Birdwood 1896, Bole and Almeida 1981, Cooke 1903, Hemadri 1971, Razi 1953, Santapau 1951, 1953, 1957; Tosh and Vartak 1985, Varadpande 1973, Vartak 1957, 1960, 1964; Vartak and Kumbhojkar 1984) showed that studies on agroecology and geographical distribution of legumes in this area are lacking. This study was, therefore, undertaken to collect data on this aspect of leguminous plants. The area of hilly regions in Pune and Satara districts in Maharashtra were selected for the study.

The paper presents data on floristic and ecological distribution of 242 species of legumes from the area under study. It is hoped that this contribution would yield useful data for critical studies on legumes in different disciplines.

The data for the study have been collected under two projects namely "Studies on Nitrogen fixing legumes from Maharashtra State" and "Floristic studies on sacred groves along western ghats of Maharashtra State", being operated at our Institute with active participation of the Botany and Microbiology Departments. During routine botanical collection tours for the project work special efforts were made to collect leguminous plants with their root nodules, seeds, cuttings and seedlings for maintaining in M.A.C.S. nursery and preparation of herbarium specimens.

TOPOGRAPHY OF THE STUDY AREA

The area covered in this work includes the hilly regions of Pune and Satara districts (17° 45′-19° 00′ N. lat. and 73 ° 15′-74° 04′ E. long.) spread over an area of approximately 15,000 sq. km. Historical forts like Sinhgad, Purandhar, Rajgad, Torna, Shivneri, Rohida, etc., and hill stations like Mahabaleshwar, Raireshwar, Khandala are included in the investigation of this work. The terrains around these locations have also been visited many times during botanical plant collection tours.

Climate

The year is divided into three marked

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seasons: the cold season from November to February, the hot season from March to May and the rainy season from June to October. During the hot season the diurnal maximum temperature rises above 42.25°C, and temperatures as high as 46.25°C have been occasionally recorded. Rainfall pattern shows that the climate is "monsoon type", average about 150 cm.

MATERIALS AND METHODS

The plant materials collected were properly identified by using different floras and by referring to the herbaria of B.S.I. (Poona) and Blatter Herbarium, Bombay. They are preserved in M.A.C.S. herbarium after proper processing. The data collected have been presented on the basis of habitats.

GENERAL ACCOUNT OF LEGUMES

To study the floristics, ecology as well as the geographical distribution of leguminous species, the area under study can be divided into the western ghat range and the plains.

a) **Legume flora of ghats and mountains:**

Common legume constituents of the general vegetation of this area contain arboreal to herbaceous floral elements.

Tall, robust, and very beautiful trees we found in this area. Some of them are evergreen, but almost all others are deciduous. They are as follows:

Butea monosperma (Lamk.) Taub. (*Butea frondosa* Koen.); *Dalbergia lanceolaria* Linn.; *D. latifolia* Roxb.; *D. paniculata* Roxb.; *D. sissoo* Roxb.; *Erythrina suberosa* Roxb.; *E. stricta* Roxb.; *E. variegata* L. (*E. indica* Lamk.); *Ougeinia oojeinensis* (Roxb.) Hochr. (*O. dalbergioides* Benth.); *Pongamia pinnata* (L.) Pierre (*P. glabra* Vent.); *Pterocarpus marsupium* Roxb.; *Bauhinia purpurea* Linn.; *B. racemosa* Lamk.; *B. variegata* L.; *Caesalpinia sappan* L.; *Cassia fistula* L.; *Delonix elata* Gamble; *D. regia* Raf.; *Hardwickia binata* Roxb.; *Piliostigma malabaricum* (Roxb.) Benth. (*Bauhinia malabarica* Roxb.); *P. foveolatum* (Dalz.) Thoth. (*Bauhinia foveolata* Dalz.); *Saraca asoca* (Roxb.) de Wilde (*S. indica* L.).

THORNY AND SPINY SPECIES:

Acacia catechu Willd.; *A. chundra* (Rottler) Willd.; (*A. catechu* Willd. var. *sundra* (DC.) Prain); *A. intsia* Willd.; *A. leucophloea* (Roxb.) Willd.; *A. polycantha* Willd. (*A. suma* Buch.-Ham.); *A. tomentosa* Willd.

NON-THORNY SPECIES:

Albizia amara Boiv.; *A. chinensis* (Osb.) Merrill (*A. stipulata* Boiv.); *A. lucida* Benth.; *A. odoratissima* Benth.; *A. procera* Benth.

Common undershrubs, shrubs and scandent shrubs:

Atylosia lineata Wt. & Arn.; *A. sericea* Benth.; *Crotalaria leptostachya* Benth.; *C. retusa* L.; *Dalbergia sympathetica* Nimmo.; *Desmodium gangeticum* DC.; *D. heterocarpon* (L.) DC. (*D. polycarpum* DC.); *D. triangulare* (Retz.) Merrill (*D. cephalotes* Wall. var. *congestum* Prain); D. velutinum (Willd.) DC. (*D. latifolium* DC.); *Flemingia strobilifera* R. Br.; *Indigofera cassioides* Rottl. ex DC. (*I. pulchella* Roxb.); *I. tinctoria* L.; *I. trita* L.; *I. trita* L. var. *maffei* Ali (*I. oreophila* Sant. & Panthki); *I. trifoliata* L.; **Mundulea** *sericea* (Willd.); *A. cheval* (*M. suberosa* (DC.) Benth.); *Tephrosia coccinea* Wall.; *T. pentaphylla* (Roxb.) G. Don. (*T. senticosa* Wt.); *T. pulcherrima* (Baker) Gamble; *T. tinctoria* Pers.; *Sesbania bispinosa* (Jacq.) W. F. Wight (*S. aculeata* Poir.); *Caesalpinia decapetala*

(Roth.) Alst. (*C. sepiaria* Roxb.); *Cassia auriculata* L.; *C. sophera* L.; *C. surattensis* Burm. var. *surattensis* Chatt. (*C. glauca* Lamk.); *Acacia farnesiana* Willd.; *A. latronum* Willd.; *A. pennata* Willd.; *A. sinuata* (Lour.) Merrill (*A. concinna* DC.); *A. torta* (Roxb.) Crab. (*A. caesia* Willd.), and *Mimosa hamata* Willd.

Among the tall and robust climbers and climbers commonly noticed are:

Abrus precatorius L.; *Butea superba* Roxb.; *Dalbergia volubilis* Roxb.; *Derris scandens* Benth.; *Caesalpinia nuga* Ait.; *Mezoneuron cucullatum* (Roxb.) Wt. & Arn.; *Wagatea spicata* Dalz.

COMMON TWINERS:

Atylosia platycarpa Benth.; *A. scarabaeoides* (L.) Benth.; *Canavalia gladiata* (Jacq.) DC. (*C. ensiformis* DC.); *C. stocksii* Dalz.; *Dolichos bracteatus* Baker; *Dumasia villosa* DC.; *Mucuna monosperma* DC.; *M. pruriens* DC.; *Neonotonia wightii* Lackey (*Glycine wightii* Verd.); *Nogra dalzelli* (Baker) Merr. (*Grona dalzellii* Bak.); *Paracalyx scariosa* (Roxb.) Ali (*Cylista scariosa* Roxb.); *Pueraria tuberosa* DC.; *Rhynchosia hirta* (Andr.) Meikle & Verd. (*R. cyanosperma* Benth.); *R. minima* (L.) DC. var. *laxiflora* Baker; *Teramnus labialis* Spreng; *Vigna catjang* Walp.; *V. unguiculata* Walp.; *V. vexillata* A. Rich. var. *sepiaria* Babu; *V. vexillata* A. Rich. var. *stocksii* Benth.; *V. vexillata* A. Rich. var. *vexillata.*

HERBACEOUS LEGUMES:

Alysicarpus beddomei Schindl. (*Desmodium rotundifolium* Baker); *A. belgaumensis* Wt.; *A. bupleurifolius* (L.) DC.; *A. longifolius* Wt. & Arn.; *A. monilifer* (L.) DC.; *A. procumbens* (Roxb.) Schindl. (*A. hamosus* Edgew); *A. pubescens* Law.; *A. racemosus* Benth. (*A. belgaumensis* var. *racemosus* Baker); *A. rugosus* DC.; *A. rugosus* DC. var. *heyneanus* Baker; *A. rugosus* DC. var. *ludens* Baker; *A. rugosus* DC. var. *styracifolius* Baker; *A. tetragonolobus* Edgew.; *A. vaginalis* (L.) DC.; *A. vaginalis* DC. var. *nummularifolia* Baker; *A. vasvadae* Hemadri; *Clitoria biflora* Dalz.; *Crotalaria albida* Heyne; *C. bifaria* L. f.; *C. calycina* Schrank; *C. filipes* Benth.; *C. filipes* Benth. var. *tricophora* Cooke; *C. hebecarpa* (DC.) Rudd. (*Goniogyna hirta* DC.); *C. juncea* L.; *C. linifolia* L.; *C. medicaginea* Lamk.; *C. medicaginea* Lamk. var. *neglecta* Baker; *C. mysorensis* Roth; *C. nana* Burm.; *C. orixensis* Willd.; *C. pallida* Ait. (*C. striata* DC.); *C. prostrata* Rottl. (*C. prostrata* Roxb.); *C. stocksii* Benth.; *C. triquetra* Dalz.; *C. vestita* Baker; *Desmodium alysicarpoides* Van Meeuwen (*D. parviflorum* (Dalz.) Baker); *D. dichotomum* (Willd.) DC., (*D. diffusum* DC.); *D. gangeticum* DC. var. *maculatum* Baker *D. reniforme* DC.; *Dolichos falcatus* Klein ex Willd.; *Flemingia gracilis* (Mukherjee) Ali (*Maughania gracilis* Mukherjee); *F. nilgheriensis* (Baker) Wt.; *Indigofera cordifolia* Heyne, *I. dalzellii* T. Cooke; *I. deccanensis* Sanjappa; *I. glandulosa* Roxb.; *I. glandulosa* Roxb. var. *sykesi* Baker; *I. linifolia* (L.f.) Retz.; *I. linifolia* Retz. var. *campbelli* Wt.; *I. linnaei* Ali (*I. enneaphylla* L.); *I. nummularifolia* (L.) Livera ex Alst. (*I. echinata* Willd.); *I. santapau* Sanjappa; *I. spicata* Forsk. (*I. endecaphylla* N. Jacq., *"hendecaphylla"*,); *I. trita* L. var. *purandharensis* Sanjappa; *Pseudarthria viscida* (L.) Wt. & Arn.; *Smithia agharkarii* Hemadri; *S. bigemina* Dalz.; *S. blanda* var. *racemosa* Baker; *S. conferta* Sm.; *S. hirsuta* Dalz.; *S. purpurea* DC.; *S. pycnantha* Benth.; *S. salsuginea* Hance; *S. sensitiva* Ait.; *S. sensitiva* Ait. var. *fulva* Cooke; *S. setulosa* Dalz.; *Taverniera cuneifolia* Arn. (*T. nummularifolia* Baker); *Tephrosia purpurea* Pers.; *T. strigosa* (Dalz.) Sant. & Mahesh. (*T. tenuis* Wall.); *T. tinctoria* Pers.; *T. uniflora* Pers. (*T. pauciflora* Grah. ex Baker); *Trigonella occulata*

Delile; *Vigna aconitifolia* (Jacq.) *Marechal* (*Phaseolus aconitifolius* Jacq.); *V. angularis* (Willd.) Ohwi & Ohashi (*Phaseolus angularis* (Willd.) Wt.; *V. dalzelliana* (O. Ktze.) Verdc. (*Phaseolus dalzellii* Cooke); *V. khandalensis* (Sant.) Rag. & Wad. (*Phaseolus khandalensis* Sant.); *V. radiata* var. *sublobata* (Roxb.) Verd. (*Phaseolus sublobatus* Roxb.); *V. radiata* Wilczek (*Phaseolus radiatus* L.); *V. trilobata* (L.) Verdc. (*Phaseolus trilobatus* Ait.); *Zornia gibbosa* Span. (*Z. diphylla* Pers.); *Cassia absus* L.; *C. mimosoides* L.; *C. obtusifolia* L.; *C. pumila* Lamk.; *C. tora* L.

b) **Legume flora of the plains:**

1. General vegetation of scattered trees of *Erythrina suberosa* Roxb.; *E. variegata* L. var. *alba*; *Acacia nilotica* (L.) Del. subsp. *indica* (Benth.) Brenan var. *cupressiformis* (Stewart) Vaj. & Kamble; *A. nilotica* (L.) Del. subsp. *vediana* (Cooke) Vajravelu & Kamble; *A. eburnea* Willd.; *Dichrostachys cinerea* Wt. & Arn.; *Prosopis cineraria* (L.) Druce; have established themselves in waste and drier areas.

2. *Seasonal vegetation*: Annual and perennial herbs which put forth shoots annually from underground parts at different seasons of the year.

COMMON LEGUMES OF CULTIVATED LANDS:

Aeschynomene indica L.; *Alysicarpus tetragonolobus* Edgew.; *Indigofera cordifolia* Heyne; *I. glandulosa* Roxb.; *Melilotus indica* All.; *Psoralea corylifolia* Linn.; *Sesbania bispinosa* (Jacq.) Wt. (*S. aculeata* Poir.); *Sesbania sesban* (L.) Merr. (*S. aegyptica* Poir.); *Vigna trilobata* (L.) Verdc. (*Phaseolus trilobatus* Ait.); *Cassia pumila* Lamk.

PROMINENT COMMUNITIES OF LEGUMES DURING RAINY SEASON IN PASTURE LANDS AND LAWNS:

Alysicarpus bupleurifolius (L.) DC.; *A. procumbens* (Roxb.) Schindl. (*A. hamosus* Edgew.); *A. tetragonolobus* Edgew.; *A. vaginalis* (L.) DC.; *Crotalaria filipes* Benth.; *Crotalaria nana* Burm.; *C. orixensis* Willd.; *Desmodium dichotomum* (Willd.) DC. (*D. diffusum* DC.); *D. triflorum* (L.) DC.; *Geissaspis cristata* Wt. & Arn.; *G. tenella* Benth.; *Indigofera cordifolia* Heyne; *I. glandulosa* Roxb.; *I. hirsuta* L.; *Smithia bigemina* Dalz.; *S. hirsuta* Dalz.; *S. purpurea* DC.; *S. pycnantha* Benth.; *Stylosanthes fruticosa* (Retz.) Alst. (*S. mucronata* Willd.); *Tephrosia uniflora* Pers.; *Lathyrus aphaca* L.; *Medicago lupina* L.; *Vicia hirsuta* Koch.; *Zornia gibbosa* Span. (*Z. diphylla* Pers.); *Cassia pumila* Lamk.; and *Mimosa pudica* L. These communities survive well where moisture is available.

LEGUMES OF DRIED ROCKY SOIL:

Alysicarpus monilifer DC.; *A. pubescens* Law.; *A. vasvadae* Hemadri; *Indigofera hochstetteri* Baker (*I. anabaptista* Steud. ex Baker); *I. linifolia* Retz.; *I. linnaei* Ali; *I. spicata* Forsk.; *Mundulea sericea* (Willd.) A. Cheval; *Tephrosia purpurea* Pers.; *Cassia auriculata* L.

HEDGE LEGUMES:

Some legumes grow along the hedges, i.e. along the bunds of the cultivated fields and house boundaries. These are:

Canavalia gladiata DC.; *Clitoria ternatea* Linn.; *Rhynchosia minima* DC.; *Paracalyx scariosa* Ali; *Caesalpinia crista* L.; *C. decapetala* Alston.

SALINE LAND LEGUMES:

Due to excess irrigation the salinity of the soil increases. A few legumes grow well in saline soil, like:

Sesbania bispinosa (Jacq.) Wt.; *Acacia nilotica* (L.) Willd.; *Prosopis juliflora* (Sw.) DC.

LEGUME FLORA OF WATER-LOGGED SOIL:

Few species grow in water-logged area as aeration of soil is very poor. These are:

Aeschynomene indica L.; *Smithia purpurea* DC.; *S. sensitiva* Ait.; *Cassia pumila* Lamk.

WASTE LAND LEGUMES:

Waste lands are areas which are not cultivated. In such sites for example roadsides exotics predominate, These are:

Desmodium scorpiurus (Swartz) Desvaux; *Rhynchosia rothii* Benth. (*R. sericea* Span.); *Tephrosia purpurea* Pers.; *Cassia hirsuta* L.; *C. occidentalis* L.; *C. tora* L.; *C. uniflora* Mill.

LEGUME FLORA OF SACRED GROVES:

Sacred groves are undisturbed forests kept inviolate in the name of Gods and Goddesses. Occurrence of giant climbers like *Entada pursaetha* DC. (*E. scandens* Benth.); *Dalbergia volubilis* Roxb.; *Mucuna monosperma* DC.; *Mezoneuron cucullatum* Wt. & Arn.; *Wagatea spicata* Dalz. was noticed in such places. Especially *Entada pursaetha* DC. is found only inside sacred groves. Other legumes are:

Acacia pennata (L.) Willd.; *A. sinuata* (Lour.) Merr. (*A. concinna* DC.); *Albizia amara* (Roxb.) Boiv.; *A. chinensis* (Osb.) Merr.; *Dalbergia sympathetica* Nimmo; *Pongamia pinnata* (L.) Pierre.

PLANTATION AND NORMAL FORESTS:

Because of excessive biotic interference, particularly due to deforestation the plains are almost denuded and devoid of natural forests. The rehabilitatory steps taken by the forest department and public have resulted in extensive plantation in the remnants of the natural forests as well as in waste places. Farm forestry constitutes one of the most conspicuous aspects of the vegetation and is an integral part of the forests in the area. Some legumes figure prominently in the afforestation programme of the area. Important species among these are:

Dalbergia melanoxylon Guill & Pers.; *D. sissoo* Roxb.; *D. lanceolaris* L.; *Pongamia pinnata* (L.) Pierre; *Cassia siamea* Lamk.; *Acacia auriculiformis* A. Cunn.; *Albizia lebbeck* (L.) Willd.; *Leucaena leucocephala* (Lamk.) de Wit. (*L. glauca* Benth.). These species are naturalized to the climatic conditions of Pune and Satara districts and show better growth performance. They are, therefore, recommended for afforestation programmes in the area.

ORNAMENTAL LEGUMES:

The species planted in public gardens and Botanical gardens as ornamental plants are: *Millettia atropurpurea* Benth.; *M. ovalifolia* Kurz.; *Phaseolus vulgaris* Linn.; *Sesbania grandiflora* (L.) Pers.; *Sophora tomentosa* L.; *Trifolium alexandrium* Delile.

Many species occurring *Acrocarpus fraxinifolius* W. & A.; *Bauhinia acuminata* L.; *B. galpini* Brown; *B. hookeri* F. Muell.; *B. purpurea* L.; *B. variegata* L.; *Brownea grandiceps* Jacq.; *Caesalpinia pulcherrima* Swartz; *C. coriaria* Willd.; *C. ferrea* Mart.; *Cassia fistula* L.; *C. grandis* L.; *C. nodosa* Buch.-Ham.; *C. renigera* Wall.; *C. roxburghii* DC.; *C. spectabilis* DC.; *C. surattensis* Burm. var. *surattensis* Chatt.; *Delonix regia* Raf.; *Saraca asoca* (Roxb.) de Wilde.; *Adenanthera pavonina* L.; *Calliandra brevipes* Benth.; *C. haematocephala* Hask.

ROADSIDE LEGUMES:

A few species of legumes are planted along roadside for shade and shelter.

Dalbergia melanoxylon Guill & Pers.; *Pongamia pinnata* (L.) Pierre; *Cassia siamea* Lamk.; *Peltophorum pterocarpum* (DC.) Baker ex Heyne; *Tamarindus indica* L.; *Acacia nilotica* (L.) Willd.; *Parkia biglandulosa* Wt. & Arn.; *Samanea saman* (Jacq.) Merr.

LEGUMES USED AS GREEN MANURE:

Some species of legumes are used as green manure. They are *Crotalaria juncea* L.; *Sesbania sesban* (L.) Merr.

CULTIVATED LEGUMES:

Some species are cultivated more widely in this area. These are:

Arachis hypogea L.; *Cajanus cajan* (L.) Millsp.; *Cyamopsis tetragonoloba* Taub. (*C. psoralioides* (Lamk.) DC.); *Lablab purpureus* (L.) Sweet. (*Dolichos lablab* L.); *Macrotyloma uniflorum.* (Lam.) Verd. (*Dolichos uniflorus* L.); *Phaseolus lunulatus* L.; *Pisum sativum* L.; *Psophocarpus tetragonolobus* DC.; *Trigonella foenum-graecum* L.; *Vigna mungo* (L.) Hopper; *V. radiata* (L.) Wilczsek.

INTRODUCED LEGUMES:

In all 41 species are introduced. Some of these are now naturalised in this area. These are:

Arachis hypogea L.; *Cajanus cajan* (L.) Millsp.; *Gliricidia sepium* (Jacq.) Kunth.; *Millettia atropurpurea* Benth.; *M. ovalifolia* Kurz.; *Macroptilium atropurpureum* (Benth.) Urb.; *Phaseolus vulgaris* Linn.; *Acrocarpus fraxinifolius* W. & A.; *Bauhinia acuminata* L.; *B. galpinii* Brown; *B. hookeri* Muell.; *B. monandra* Kurz.; *B. tomentosa* L.; *Brownea grandiceps* Jacq.; *Caesalpinia coriaria* Willd.; *C. ferrea* Mart.; *C. pulcherrima* Sw.; *Cassia alata* L.; *C. angustifolia* Vahl; *C. didymbotria* Fresen; *C. grandis* L.; *C. javanica* L.; *C. nodosa* Buch.-Ham.; *C. renigera* Wall.; *C. roxburghii* DC.; *C. siamea* Lamk.; *C. spectabilis* DC.; *Ceratonia siliqua* L.; *Colvillea racemosa* Boj.; *Delonix regia* Raf.; *Haematoxylon campechianum* L.; *Parkinsonia aculeata* L.; *Peltophorum pterocarpum* (DC.) Baker ex Heyne; *Acacia auriculiformis* A. Cunn.; *Calliandra brevipes* Benth.; *C. haematocephala* Hask.; *Desmathus virgatus* Willd.; *Leucaena leucocephala* Hassk.; *Parkia biglandulosa* Wt. & Arn.; *Pithecellobium dulce* (Roxb.) Benth.; *Samanea saman* (Jacq.) Merr.

RARELY OCCURRING SPECIES:

Geissaspis tenella Benth.; *Rhynchosia hirta* (Andr.) Meikle & Verdc., and *Smithia pycnantha* Benth. This paper mainly describes the ecological distribution pattern of the legumes and their adaptation to a particular habitat in addition to the taxonomy of relevant taxa. Data on this aspect of legumes were not available for this area.

The analysis of the genera and species covered is presented in the following table:

Family name	No. genera	No. species	No. varieties
Fabaceae	54	155	19
Caesalpiniaceae	17	53	1
Mimosaceae	13	34	2
Total:	84	242	22

DISCUSSION

In all 242 species belonging to 84 genera of the 3 families of legumes have been collected and recorded. Legumes are the most important component of the natural vegetation of local floras. Economically legumes are sources of food. fodder, timber, dyes, gums, resins, oil, medicine, green manure, etc. Growing in every soil type and climatic conditions, they show great variety in habit, e.g. trees, shrubs, scandent shrubs, herbs, climbers, twiners, etc. Some of them are excellent soil binders and are often planted for checking soil erosion. The use of leguminous plants in soil improvement projects has been given top priority by Agriculture and Forest Departments. Legumes enrich the soil either by fixing the atmospheric nitrogen through their root nodules and liberating it as these decay, or by ploughing in the whole plant as green manure. It is always a beneficial practice to take a crop of pulses after cereals.

During the present study *Macroptilium atropurpureum* (Benth.) Urb. has been recorded as new to Maharashtra State and Goa. It is an introduced species from U.S.A. *Millettia atropurpurea* Benth. has been also reported as new to this state.

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NEW DESCRIPTIONS

A NEW SPECIES OF *MARPISSA* KOCH (ARANEAE: SALTICIDAE) FROM INDIA[1]

Kanchan Monga[2], J. P. Singh[3] and G. L. Sadana[4]

(*With two text-figures*)

A new species of genus *Marpissa* from Northern India is described.

All type specimens will, in due course, be deposited in the collections of the Zoological Survey of India, Calcutta.

Marpissa singhi sp. nov. (Figs. 1-2)

Female cephalothorax: Carapace: length 1.84 mm; maximum breadth 1.52 mm; about four fifth as wide as long, with sides curved outwards, flattened, yellow, covered with fine pubescence. Cephalic region not distinctly marked from thoracic region. Eyes: eight, transparent, encircled by black rims; arranged in three rows, ocular quad less than half the length of cephalothorax. Diameter of eyes (mm): A.M. = 0.27; A.L. = 0.10; P.M. = 0.07 and P.L. = 1.15. Mutual distances between the eyes (mm): A.M. – A.M. = 0.49; A.M. – A.L. = 0.40; A.M. – P.M. = 0.56; A.M. – P.L. = 0.89; P.M. – P.M. = 1.11; P.M. – P.L. = 0.40; P.L. – P.L. = 1.13 and A.L. – A.L. = 1.20. Width of clypeus: 0.01 mm. Chelicerae: yellow with two teeth on promargin and one on retromargin. Maxillae: yellow, broad at anterior end and narrower at base with thick black scopulae at anterior margin. Labium: yellow, subtriangular, with a few brown stiff hairs at anterior end. Sternum: yellow with a few brown hairs, convex, oval, narrow at anterior end, smaller in width than the base of labium. Tibia and metatarsi I & II with three and two pairs of ventral spines, respectively. Coxae of legs separated by a distance less than their own diameter. Length of legs (mm):

Leg	Coxa	Trochanter	Femur	Patella	Tibia	Metatarsus	Tarsus	Total
I	0.17	0.10	0.93	0.20	0.57	0.43	0.33	2.73
II	0.17	0.10	0.73	0.23	0.40	0.27	0.37	2.27
III	0.17	0.07	0.67	0.17	0.33	0.27	0.30	1.98
IV	0.17	0.10	0.77	0.20	0.50	0.40	0.30	2.44

Abdomen: Length 2.48 mm; maximum breadth 1.52 mm; flattened, oval in shape, projecting over the cephalothorax to obscure pedicel. Dorsum yellow with a light streak in the centre of the posterior half and covered all over with brown hairs. Venter yellow, with a pair of thin streaks extending from epigastric furrow to spinnerets. Epigynum as in Fig. 2.

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[1] Accepted August 1988.

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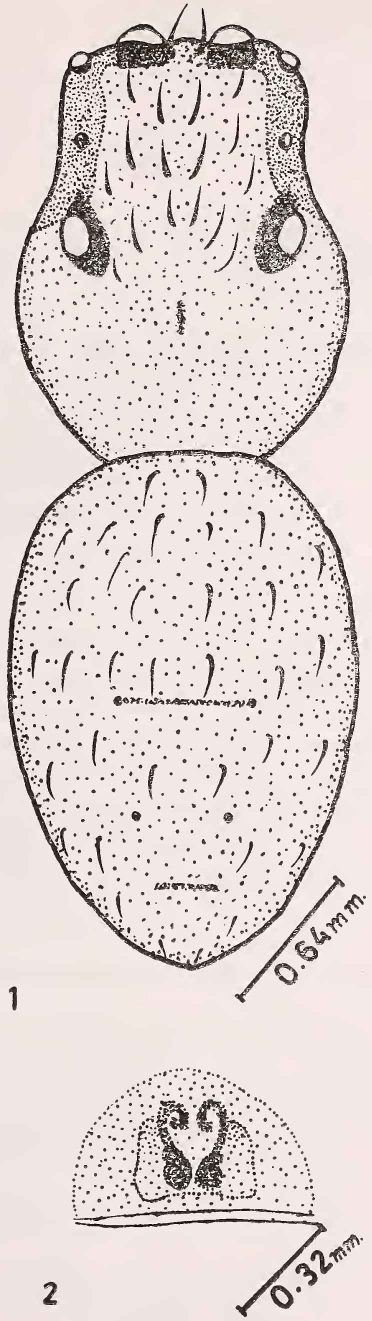
[3] Department of Zoology, Punjabi University, Patiala.

[4] Department of Zoology, Punjab Agricultural University, Ludhiana.

Total length: ♀ 4.32 mm.

Holotype: ♀, in spirit, INDIA: HARYANA: Kalesar Reserve Forest, Dist. Ambala, 4.v.1979, K. Monga.

This species resembles slightly with *Marpissa andamanensis* Tikader but can be distinguished from it by the considerable difference in size, absence of white bands on cephalothorax, and presence of a light streak in the posterior half of the abdomen instead of longitudinal patch present mid-dorsally in *M. andamanensis*. The structure of epigynum is also different.



Figs. 1-2. *Marpissa singhi* sp. nov.: 1. Dorsal view of female; 2. Epigynum.

ACKNOWLEDGEMENTS

We thank the Professor and Head, Department of Zoology, Punjabi University, Patiala for providing laboratory facilities.

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TWO NEW SPECIES OF GENUS *DYSTROPICUS* PASCOE (COLEOPTERA: CURCULIONIDAE: CRYPTORHYNCHINAE) FROM INDIA[1]

L. S. Arya[2] and H. R. Pajni[3]

(*With twelve text-figures*)

Two new species *Dystropicus glabriscutellus* and *D. madhyapradeshi* have been described and illustrated. Descriptions of external genitalia of old species, namely, *D. dorsalis* and *D. clitella* are included. A key to the Indian species is also given.

INTRODUCTION

The genus *Dystropicus* Pascoe has so far been represented in India by only two species, namely. *Dystropicus dorsalis* Faust 1898 and *D. clitella* Faust 1898. Both species were recorded from the Eastern Himalayas and were described inadequately. During the present studies, an extensive survey of Northern India was made under PL-480 project on Curculionidae during 1975-81 and some unidentified collection from F.R.I., Dehra Dun (U.P.) was also borrowed. Consequently, as many as 70 species belonging to Cryptorhynchinae comprising 31 known species, 27 new species and 12 first records from India were studied. This paper describes two new species of the genus as well as the description of external genitalia of known species. Besides, the genus itself has also been recharacterised. A key to the Indian species is provided.

Genus **Dystropicus** Pascoe

Dystropicus Pascoe, *Ann. Mus. Civ. Genova*, (2)11, 1885, p. 252, — Morimoto, *Esakia* (11), 1978, p. 127.

Berosiris Lea (nec Pascoe), *Proc. Linn. Soc. n. s. Wales* XXXII, 1907, p. 415; *Trans. Roy. Soc. S. Austr.* XXXVII, 1913, p. 307.

Head with eyes distinctly granulate, subapproximate beneath. Rostrum thin, distinctly separated from head, with scrobe oblique, not visible from above. Antennae relatively long, inserted at middle of rostrum, each with distinct club. Pronotum transverse, extending over head anteriorly, with prominent ocular lobes. Scutellum small and bare. Elytra broader than pronotum, longitudinally moderately convex. Legs short; femora thick and hardly clavate, dentate below; tibiae short, compressed, externally arcuate, armed; tarsi short, with claws free. Sternal canal surpassing hind end of midcoxae, sometimes extending beyond middle of metasternum; metasternum longer than ventrite 3. Abdominal segment 2 longer than 1.

Type-species: *Dystropicus squalidus* Pascoe.

KEY TO THE SPECIES OF GENUS *Dystropicus* PASCOE

1. Rostrum as long as pronotum. Sternal canal reaching hind end of mid-coxae 2
   Rostrum at least as long as head and pronotum together. Sternal canal extending far behind mid-coxae 3
2. Eyes strongly approximate. Elytra with shoulders oblique. Metasternum sloping inward .... *dorsalis* Faust
   Eyes hardly approximate. Elytra with shoulders roundly rectangular. Metasternum not sloping inward .... *glabriscutellus* sp. nov.
3. Eyes strongly approximate. Funicular segment 2 longer than 1. Elytra with longitudinal white

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stripes near outer margins ....
.... *madhyapradeshi* sp. nov.
Eyes sub-approximate. Funicular segment I as long as 2. Elytra without stripes ....
.... *clitella* Faust

Dystropicus dorsalis Faust
(Figs. 1,2)

Faust, *Deutsche Ent. Zeitschr.*, 1898, p. 317.

Male genitalia with aedeagus parallel-sided, subtruncate posteriorly, uniformly and weakly sclerotized; aedeagal apodemes longer than aedeagus, slightly broader in apical half than basal part; phallotreme apical; phallobasic ring complete, somewhat broad; with apodeme tubular and short; parameres median. Gastral spiculum with median arm flattened at apical tip, more sclerotized at sides.

Dystropicus clitella Faust
(Figs. 3-6)

Faust, *Deustache Ent. Zeitschr.*, 1898, p. 316.

Male genitalia with aedeagus parallel-sided, constricted behind middle, truncate posteriorly, uniformly sclerotized; aedeagal apodeme twice as long as aedeagus, strongly sclerotized except for apical tip; phallotreme subapical; phallobase as complete ring, weakly sclerotized, with rather short apodeme; parameres longer than phallobasic apodeme. Gastral spiculum with median arm rather long, strongly sclerotized. Female genitalia with coxites rather long, moderately sclerotized; styli strongly sclerotized, furnished with fine setae at apical tip; spiculum ventrale with lateral arms rather narrow, straight, approximate, as sclerotized as median. Spermatheca with cornu slightly curved, broadest at base, gradually narrowed behind, not pointed at tip; collum as well as ramus indistinct.

Dystropicus glabriscutellus sp. nov.
(Figs. 7-9)

Head piceous, densely clothed with recumbent interspersed with a few suberect fulvous scales; eyes silvery white, latero-ventral, ovate, subapproximate below. Rostrum piceous, as broad at base as frons, as long as pronotum, subcylindrical, widest at base gradually narrowed behind, acarinate, closely punctate from base to antennal insertion but finely and remotely so behind, squamose with pale scales in basal half and finely setose in apical half. Antennae ferruginous, inserted behind middle of rostrum; scape rather long, beset with pale setae in basal region but with black setae in clavate region; funicle densely pubescent, with joint 2 twice as long as 1, 3-6 longer than broad, 7 as long as broad; club fusiform, rather narrow, laterally compressed, with joint 1 longer than 2.

Pronotum piceous, longer than broad, parallel-sided in basal four-fifth and then abruptly narrowed towards apex, with prominent subapical constriction, bisinuate at base; dorsal surface beset with recumbent black scales forming median longitudinal wide stripe interspersed with a few erect scattered black scales and two tufts of black scales — one on either side of median line in middle surrounded by light-brown stripes of recumbent veined scales along with a few erect scales, whereas laterally furnished with darkbrown recumbent and a few erect scattered scales.

Scutellum black, shiny, slightly longer than broad, bare.

Elytra piceous, broader at base than pronotum, with roundly rectangular moderately developed shoulders, parallel-sided in basal third gradually tapering behind, without subapical calli, longitudinally convex, with base at a lower level; striae narrow, with punctures elongate or rounded; intervals densely clothed with overlapping recumbent scales along with a few erect scales forming tufts at intervals 2 and 3 in basal half, interval 1 elevated behind declivity; elytral vestiture light-dark variegated with pale and dark-brown patches unevently scattered all over.

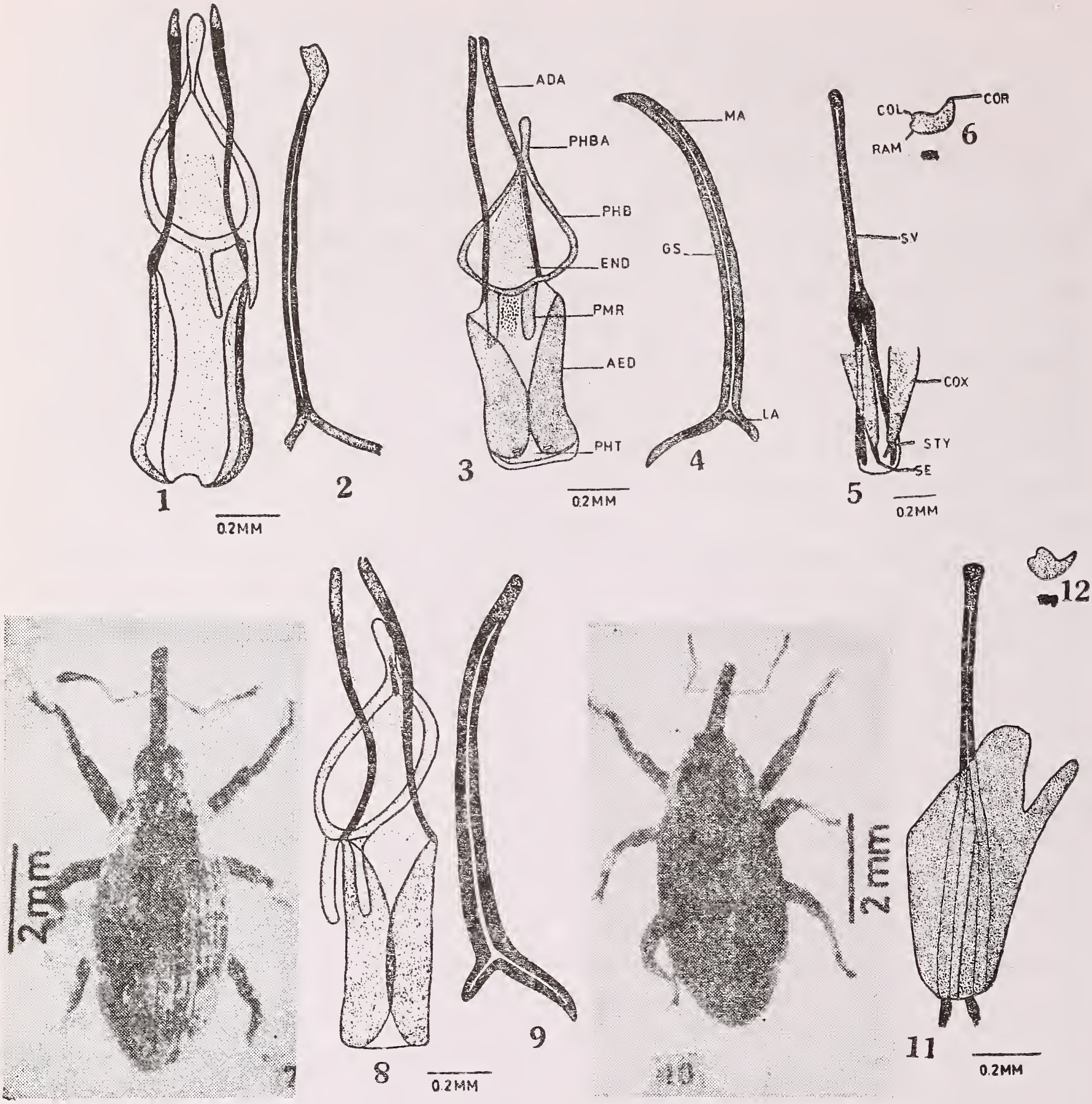
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Fig. 1. Male genitalia of *Dystropicus dorsalis* Fst. (dorsal view); Fig. 2. Gastral spiculum of *D. dorsalis* Fst.; Fig. 3. Male genitalia of *D. clitella* Faust. (dorsal view); Fig. 4. Gastral spiculum of *D. clitella* Faust.; Fig. 5. Female genitalia of *D. clitella* Faust.; Fig. 6. Spermatheca of *D. clitella* Faust.; Fig. 7. Adult of *D. glabriscutellus* sp. nov.; Fig. 8. Male genitalia of *D. glabriscutellus* sp. nov. (dorsal view); Fig. 9. Gastral spiculum of *D. glabriscutellus* sp. nov.; Fig. 10. Adult of *D. madhyapradeshi* sp. nov.; Fig. 11. Female genitalia of *D. madhyapradeshi* sp. nov.

Abbreviations:

ADA: Aedeagal apodeme; AED: Aedeagus; COL: Collum; COR: Cornu; COX: Coxite; END: Endophallus; GS: Gastral spiculum; LA: Lateral arm; MA: Median arm; PHB: Phallobase; PHBA: Phallobasic apodeme; PHT: Phallotreme; PMR: Paramere; RAM: Ramus; SE: Setae; STY: Stylus; SV: Spiculum ventrale.

Legs with femora subclavate, densely clothed with recumbent fullygenous scales interspersed with a few erect scales; tibia rather small, widest at base rapidly tapering behind, laterally compressed; tarsal segment 1 as long as 2 and 3 combined.

Sternal canal surpassing hind end of midcoxae. Metasternum depressed in middle but costate laterally, punctate with punctures provided with recumbent grey scales. Abdominal sternites punctate and densely clothed with recumbent grey scales.

Male genitalia with aedeagus parallel-sided, subtruncate at base, moderately sclerotized; aedeagal apodeme slightly longer than aedeagus, strongly sclerotized in basal half; endophallus without any sclerite; phallotreme apical, triangular; phallobasic ring much longer than broad, moderately sclerotized, with apodeme one-fourth as long as, but broader than aedeagal apodeme; parameres rather short, pointed at tip. Gastral spiculum with median arm straight, much broader than phallobasic apodeme, strongly sclerotized in middle; lateral arms unequal, moderately sclerotized.

Measurements: Body length: 5.60-7.00 mm.; Body width: 2.10-2.50 mm.; Rostrum length: 1.60-1.90 mm.; Rostrum width: 0.30-0.35 mm.

Material examined: Holotype: ♂; Tamil Nadu: Nilambur, Amarampallam; unknown host; C.F.C. Beason Coll.; 29.iv.1927. Paratype: 3 males; data same as that of holotype.

Remarks: This species has a general resemblance to *D. dorsalis* Faust and agrees with it in the length of the rostrum and extent of the sternal canal, in addition to other similarities. However, it can be easily separated from *D. dorsalis* Faust from the ventrally less approximate eyes which are closely approximate in the latter. In addition, the length of the prothorax and the shape of the shoulders are also different in the two species, as described under their descriptions.

Dystropicus madhyapradeshi sp. nov.
(Figs. 10-12)

Head coarsely punctate, densely clothed with recumbent light-brown flat scales; frons at a lower level than vertex; eyes silvery-white, shiny, oval, approximate below. Rostrum piceous in basal half, ferruginous in apical half, longer than head and pronotum combined, broader at base than frons, cylindrical, slightly arcuate, closely punctate in basal half but distantly and shallowly so in apical half, with punctures squamose at base whereas setose in remaining basal half, finely setose in apical half. Antennae ferruginous, inserted at middle of rostrum; funicle pubescent, with segment 2 longer than 1, thereafter diminishing in length, 3 and 4 longer than broad, 5 and 6 as long as broad, 7 transverse; club fusiform, distinctly segmented, subacuminate at tip.

Pronotum piceous, broader than long, widest and truncate at base, parallel-sided in basal half then narrowed behind, coarsely and reticulately punctate, densely clothed with black recumbent veined scales forming a broad median stripe from base to middle whereas with yellow scales in remaining region interspersed with a few erect scattered black scales.

Scutellum rounded, opaque at periphery but glabrous in middle, rather sparsely setose.

Elytra ferruginous, slightly broader at base than base of pronotum, with roundly rectangular shoulders, parallel-sided in basal third thereafter roundly narrowed towards apex, without subapical calli; striae with punctures rounded, each studded with black granules at sides as well as accommodating a horizontal seta; intervals broader than striae, densely clothed with recumbent overlapping black and dark-grey scales along with a few erect scales forming tufts on intervals 2 and 4 in basal half.

Legs with femora sublinear, densely clothed with overlapping greyish-yellow scales; tibia short, curved at base, gradually narrowed towards apex, densely squamose; tarsal segment 1 as long as 2 and 3 combined.

Sternal canal surpassing hind end of midcoxae. Metasternum behind sternal canal slightly depressed. Abdominal sternites closely punctate with punctures densely clothed with recumbent greyish-yellow scales concealing them completely.

Female genitalia with coxites fused all along their length, strongly sclerotized at sides; styli tubular, two and a half times as long as broad, furnished with a few setae at apex; spiculum ventrale with median arm rodshaped, slightly dilated at tip, more sclerotized in basal half; lateral arms rather approximate. as sclerotized as basal half of median arm. Spermatheca small; cornu slightly curved, pointed at apex; collum and ramus indistinct.

Measurements: Body length: 4.06-4.76 mm.; Body width: 1.68-2.10 mm.; Rostrum length: 1.12-1.26 mm.; Rostrum width: 0.28-0.35 mm.

Material examined: Holotype: Female, Madhya Pradesh: S. Chand; on *Bombax malabaricum*; D.F.O. Coll.; 13.x.1938. Paratype: Female; data same as that of holotype.

Remarks: This species differs from the closely allied *D. clitella* Faust in having the eyes comparatively more approximate below and in the length of the second segment of funicle which is longer than the first as compared to the equal length of these two segments in *D. clitella*.

ACKNOWLEDGEMENTS

We thank Dr. P. K. Sensarma, Forest Research Institute, Dehradun (U.P.) for lending material. The research facilities provided by the Chairman, Department of Zoology, Panjab University, Chandigarh are also gratefully acknowledged.

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A NEW SPECIES OF *ONCOCEPHALUS* KLUG (HETEROPTERA — REDUVIIDAE — STENOPODINAE) FROM SOUTHERN INDIA[1]

Dunston P. Ambrose and S. J. Vennison[2]

(*With eleven text-figures*)

Distant (1902 & 1910) in his fauna of British India, described 14 species of *Oncocephalus*.

In the present paper a new species of *Oncocephalus* Klug, viz. *O. anniei* is described and illustrated.

Key to the identification of Indian species of genus *Oncocephalus*

1. Hemelytra fully developed 2
   Hemelytra abbreviated 14
2. Anteocular and postocular areas of head almost equal in length 3
   Anteocular area of head longer than postocular area of head 5
3. Three piceous or fuscous vittae or longitudinal fasciae in the anterior lobe of pronotum 4
   Irregular mottlings with a subtriangular fascia in the anterior lobe of pronotum .... *O. picturatus* Distant
4. Five piceous or fuscous vittae in the posterior lobe of pronotum .... *O. notatus* Klug
   No piceous or fuscous vittae in the posterior lobe of pronotum .... *O. naboides* Walker
5. Anteocular portion of head longer, but not twice the length of postocular area 6
   Anteocular portion of head twice or more than twice the length of postocular area 8
6. Both anterior and posterior lateral angles of pronotum prominently subspinous .... *O. impudicus* Reut.
   Both anterior and posterior lateral angles of pronotum not prominently subspinous 7
7. Apical areas of femora, obsolete apical annulations to tibiae and base of rostrum castaneous .... *O. fuscinotum* Reut.
   Broad annulations in the entire femora and tibiae castaneous .... *O. anniei* sp. nov.
8. Head with anteocular area from eyes to base of antennae twice the length of postocular area 9
   Head with anteocular area from eyes to base of antennae more than twice the length of postocular area 13
9. First joint of antennae as long as anteocular portion of head 10
   First joint of antennae as long as head .... *O. schioedtei* Reut.
10. Black antennae outwardly curved, anterior tibiae little curved .... *O. aterrimus* Distant
    Brown or ochraceous antennae and tibiae not curved 11
11. Anterior pronotal lobe distinctly sulcate, anterior and posterior lateral angles distinctly subspinously produced ...... *O. cingalensis* Walker
    Anterior pronotal lobe not distinctly sulcate, anterior and posterior lateral angles not distinctly subspinously produced 12
12. Pale cinnamon brown membrane with discal elongate castaneous spot; anterior angles of pronotum prominently subspinous .... *O. modestus* Reut.
    Pale brownish ochraceous, membrane with brownish castaneous central cellular area, apical spine to scutellum, anterior angles of pronotum obtusely tuberculously prominent .... *O. klugi* Distant
13. Piceous brown, anteocular portion with a broad lateral and a narrow central ochraceous fascia, lateral margins of pronotum unarmed .... *O. lineosus* Distant
    Very pale brownish ochraceous, anteocular portion of head with four obsolete dark fuscous or black lines, lateral margins of pronotum armed medially with a small tubercle or tooth .... *O. annnulipes* Stal
14. Pale testaceous, pronotum with lateral median spinous tubercle about twice as long as scutellum, hemelytra without spot .... *O. micropterus* Horv.
    Dark fuscous, pronotum without lateral median spinous tubercle; hemelytra reaching only up to second abdominal segment with small fuscous spot near apex .... *O. morosus* Distant

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[1] Accepted December 1986.

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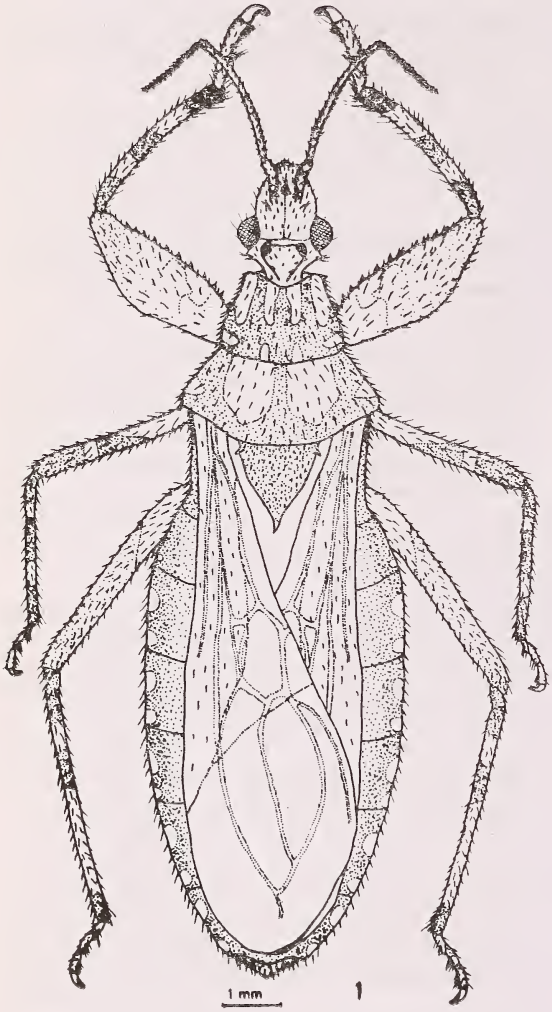
Oncocephalus anniei sp. nov.

FEMALE: Total length 12.69 mm; width across the eye 1.10 mm; across prothorax 3.07 mm. (Fig. 1).



Oncocephalus anniei sp. nov.

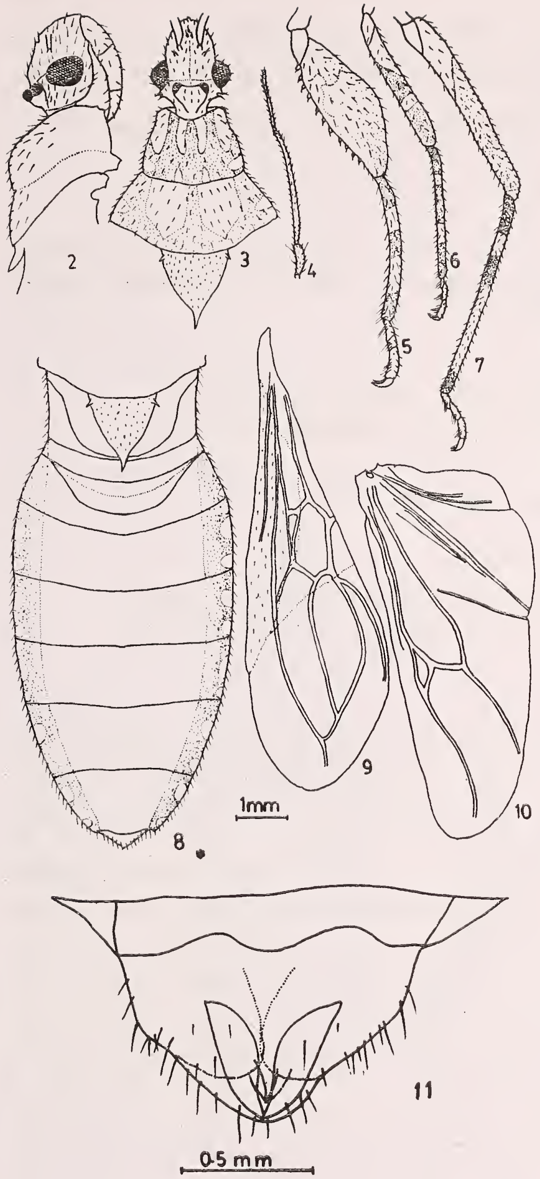
Fig. 1. Adult female.

Colour brown; compound eyes, antero- and postero-lateral angles of pronotum, two median, two lateral obsolete fasciae in the anterior lobe of pronotum and lateral broad oval areas in the posterior pronotal lobe except a median band with a broad basal area, corium, broad annulations in the femorae and tibiae and spots in the connexivum bright brownish ochraceous; pilose.

Head oblong, highly granulate, moderately porrect; anteocular portion (1.18 mm), slightly longer than postocular portion (0.80 mm); compound eyes slightly protruding transversely (0.76 mm diameter); two prominent ochraceous ocelli harboured in short, swollen, hollow stalk pointing laterally; anteocular and postocular portion is demarcated by a deep sulcus in the synthlipsis; just behind each eye three small lateral tubercles bearing stiff hairs; two prominent pilose antenniferous tubercles outwardly, one at the base of each antenna (Figs. 2 & 3); four-segmented antennae richly pilose, scape short (0.50 mm), stout and slightly outwardly deflexed pedicel elongated (2.31 mm), four times as long as scape, flagellar segments linear, first flagellar segment slightly longer (0.63 mm) than second flagellar segment (0.50 mm) (Fig. 4); rostrum (2.23 mm long) stout, scarcely pilose, tip resting in the prosternal furrow, first (0.84 mm) and second (0.76 mm) rostral segments subequal in length; the third segment the shortest (0.63 mm) (Fig. 2), neck distinct.

Pronotum 2.52 mm long and 3.07 mm broad; granulate; antero-, postero- lateral margins of pronotum obtuse, pronotum constricted slightly behind the middle by a transverse sulcus; anterior lobe raised, convex and medially longitudinally grooved, pilose; scutellum triangular with a convex disc, two basal, lateral tubercles one on each side of the disc; posterior process well developed and spiniform, slightly laterally produced, finely pilose (Fig. 3).

Legs pilose, broadly annulated, anterior femora incrassated and ampliated, bear a row of spines (eleven) beneath (Fig. 5); fore- and



Oncocephalus anniei sp. nov.

Figs. 2-11: 2&3 — head and pronotum lateral and dorsal views; 4 — antenna; 5 — fore leg; 6 — mid leg; 7 — hind leg; 8 — pterothorax and abdomen; 9 — fore wing; 10 — hind wing; 11 — genitalia.

mid-tibiae without spongy fossula, tarsi three-segmented, first and second tarsal segments subequal in length, the third segment slightly longer, fore- and mid-legs (Figs. 5 & 6) more or less equal in length, the hind legs (Fig. 7) slightly longer but not passing the abdominal apex at rest.

Hemelytra (9 mm long and 2.65 mm wide) with concolourous venation distinct on corium and membrane, not reaching the apex of abdomen, scarcely pilose on corium, the membrane polished (Figs. 9 & 10).

Abdomen elongated (8.19 mm long and 3.7 mm broad), laterally slightly pilose, centrally polished, ventrally convex, connexivum spotted, abdomen without any scent gland scars (Fig. 8) (genitalia as in fig. 11).

Type information:

Holotype (♀) collected from Muthurmalai near Sivanthipatti, in Nellai Kattabomman District of Tamil Nadu on 15.8.1986. Allotype not found. The holotype is pinned and deposited in the Research Department of Zoology, St. Xavier's College, Palayankottai, India. Paratype (one female) collected from the same locality.

O. anniei sp. nov. is closer to *O. fuscinotum* Reut. and *O. impudicus* Reut. in having fully developed hemelytra and longer anteocular portion of head which is not twice the length of the postocular portion.

But *O. anniei* can be easily distinguished from *O. impudicus* by the obtuse antero-postero-lateral angles of pronotum and from *O. fuscinotum* by the broad castaneous annulations both in the femora and tibiae.

Etymology:

This species is named after Mrs. Annie Ambrose.

ACKNOWLEDGEMENTS

We are grateful to Rev. Fr. G. Packiaraj, S.J., Principal and authorities of St. Xavier's College for facilities and encouragements. The financial assistance of CSIR (Grant No. 38/513/EMR-II-84) for this work is acknowledged.

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TWO NEW SPECIES OF PIRATINAE STAL FROM SOUTHERN INDIA (HETEROPTERA — REDUVIIDAE — PIRATINAE)[1]

DAVID LIVINGSTONE AND C. MURUGAN[2]

(*With two text-figures*)

Two new species of the genus *Pirates* and *Ectomocoris* from Southern India, namely *Pirates unipunctatus* sp. nov. and *Ectomocoris tuberculatum* sp. nov. are described and illustrated.

INTRODUCTION

The subfamily Piratinae, among the tibiaroliate group of Reduviidae, could be broadly divided into two groups, one having more elongately produced head, with antennae far removed in front of the eyes and having tibiarolium or the tibial pad developed only on the fore-tibiae and the other group having moderately elongate head with the antennae arising closer to the eyes and the fore- and mid-tibiae provided with tibiarolium. The first group is exclusive for *Sirthenea* whereas the second group includes several genera, *Ectomocoris* and *Pirates* constituting the major genera comprising of more than 90% of the recorded species of Piratinae and the diagnostic feature of these two genera is the extent of development of tibiarolium. In *Ectomocoris* the tibial pad, of the fore- and mid-tibiae extends more than half the length of each tibia whereas in Piratinae it is restricted almost to the tip of the tibia but its lobe extending almost the entire length of the first two tarsomeres. In both genera, the second segment of the rostrum is the longest, more than double the length of the first segment and in the case of *Pirates* the fore-femora is usually, provided with tuberculate spines. In *Ectomocoris,* however, no such armature has been reported to be characteristic. In the present description, the *Ectomocoris* species is provided with a row of tubercles on the fore-femora and for that reason it is described as new to science.

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[1] Contribution No. 58, Division of Entomology, Bharathiar University, Coimbatore-641 046. Accepted August 1987.

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1. **Pirates unipuntatus** sp. nov. (Fig. 1)

MALE: length 12 mm, width across the abdomen 4 mm, macropterous; elongate; head elongately ovate; fuscous with reddish tinge; testaceous; eyes black, globose; ocelli reddish brown; ocellar prominence moderately formed; anteocular and postocular areas almost equal; second segment of rostrum ochraceous, third segment fuscous and basal segment pale fuscous; antennae pale fuscous, pedicel more than double the length of the slightly incrassated scape, filamentar segments and the scape almost equal in length; scape almost as long as the anteocular area as well as the second rostral segment; pronotum unicolorous; dorsally densely clothed with tomentose hairs, discal prominence moderately developed; posterior lobe slightly convex, postero-lateral margins elevated; the transverse fissure between anterior and posterior lobes moderately deep and dark, expanded towards the exterior; carinations and sulcations of anterior lobe most obscure, densely clothed with white tomentose hairs; anterolateral tubercles obscure; epimeral prominence of the prothorax globose and porrectly produced in front of the pronotum; scutellum broadly triangular with marginal carination and central foveation; scutellar spine moderately developed, porrect, fuscous; clavus and inner margin of the corium yellowish white with a tinge of red, entire corium exclusively clothed with tomentose hairs; thorax and abdomen unicolorous, fuscous, clothed with tomentose hairs; legs unicolorous, ochraceous; fore-femora incrassated with median ventral longitudinal dark serrated carina; tibial pad of the foreleg not exceeding 1/4 of the tibiae but anteriorly the lobe reaching upto the middle of the second tarsomere.

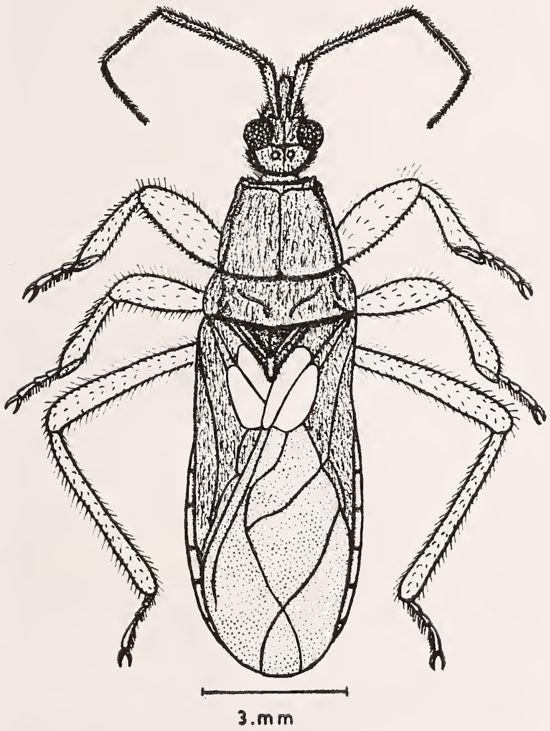

Fig. 1. *Pirates unipunctatus* sp. nov.

This species resembles *Pirates punctum* in having similar spotted hemelytra, carinated and serrated fore-femora, and in the general clothing of the body by tomentose hairs. It can be readily recognised from *P. punctum* by its smaller size, colouration of the head, pronotum and abdomen (fuscous with reddish tinge), slightly incrassated nature of the scape, the more numerous tuberculate spines of the fore-femora, more elongate second rostral segment and by the large sized black eyes.

FEMALE: Also macropterous.

Type Information

Holotype — MALE Serial No. 66, pinned specimen deposited at present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, India.

Collection Information

Holotype collected by light trap in an agroecosystem in Vadavalli, Coimbatore District, Tamil Nadu on 1.4.85 at 19.50 hours and at elevation, 500 MSL, temperature 28°C and humidity 70%. *Paratypes*: several, collected from the same location on different dates.

2. **Ectomocoris tuberculatum** sp. nov. (Fig. 2)

MALE: Length 18 mm, width across the abdomen 3 mm, macropterous, elongate, head elongately ovate, piceous, smooth; head, pronotum, scutellum, abdomen dorsally and ventrally, thorax ventrally and membrane piceous; eyes black, globose, placed vertically upward; ocelli reddish brown, separated by a broad inter-ocellar furrow; legs, scape and pedicel, first two segments of the rostrum, clavus, basal half of corium and base of the membrane ochraceous; both filamentar segments of antennae pale fuscous; scape having a brown basal ring, not exceeding the length of preocular area; third segment of the rostrum pale fuscous much shorter than second, almost as long as the first segment, second rostral segment slightly incrassated, almost as long as the scape; ocellar prominence extending laterally beyond the level of the eyes; pronotal anterior lobe almost double the length of the posterior lobe; antero-lateral tubercle porrectly produced; carinations and sulcations of the anterior lobe faintly differentiated, smooth with a median longitudinal shallow fissure throughout the length and extending up to the anterior half of the posterior lobe; the epimeral lobes of the prothorax globose, prominently projecting on either side of the collar; posterior lobe slightly convex posteriorly, lateral and discoidal prominences moderately differentiated, smooth; scutellum broadly triangular; median foveation obscure; scutellar tubercle short and porrect; corium luteous, almost entirely except the base and apex; legs unicolourous, ochraceous; fore-femora incrassated, ventrally with a row of fine brown tubercles; the tibial pads extending more than half the length of tibiae and extending anteriorly throughout the length of the first two tarsomeres.

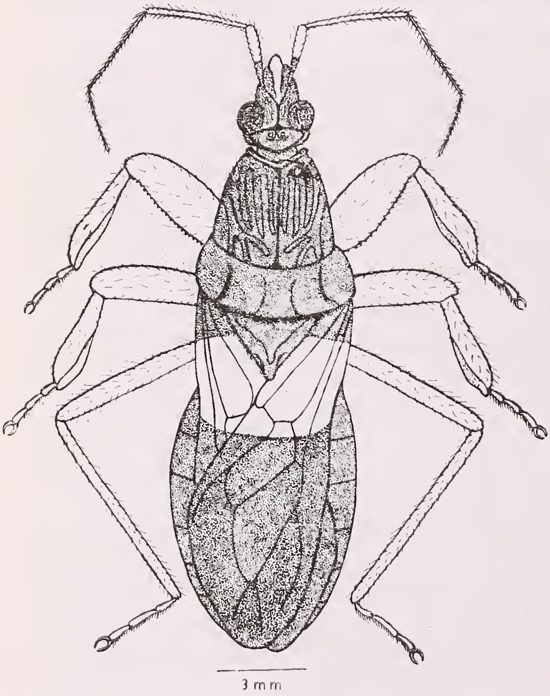

Fig. 2. *Ectomocoris tuberculatum* sp. nov.

Type Information

Holotype: MALE — Serial No. 65, pinned specimen deposited at present in the reduviid collection of the Division of Entomology, Bharathiar University, Coimbatore, India.

Collection Information

Holotype: Collected from underneath stone in Malumichampatti, Coimbatore district, Tamil Nadu on 22.8.85 at elevation 350 MSL, Temperature 28°C, humidity 70%. *Paratypes*: several, all males, collected from Madukkarai on 2.9.83 at elevation 350 MSL, temperature 29°C, humidity 52%; Maruthamalai on 1.3.84 at elevation 500 MSL, temperature 31°C, humidity 38% and also from Kovaipudur on 30.9.85 at elevation 400 MSL, temperature 33°C, humidity 74%, all the places within Coimbatore district, Tamil Nadu.

ACKNOWLEDGEMENTS

We are grateful to the authorities of the Bharathiar University, Coimbatore for providing facilities and to the Department of Science and Technology, New Delhi for financial assistance during the course of investigation. Thanks are due to the Director, Zoological Survey of India, Calcutta, for placing at our disposal their reduviid collection for comparison.

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———— (1910): ibid. Vol. V, Heteroptera, Appendix. Taylor & Francis, London, pp. 169-217.

REVIEWS

1. PLANTS IN DANGER: What Do We Know? By Stephen D. Davis, Stephen J. M. Droop, Patrick Gregerson, Louise Henson, Christine J. Leon, Jane Lamlein Villa-Lobos, Hugh Synge and Jana Zantovska. pp. xlv + 461 (23.5 cm × 16.0 cm). Gland, Switzerland and Cambridge, U.K., 1986. International Union for Conservation of Nature and Natural Resources (IUCN). Price not mentioned.

This book is intended to provide a concise guide to information on threatened plants throughout the world. Book does not provide information on each threatened species, but it shows how to find that information.

The entries in the book are arranged alphabetically by names of countries and under each entry following information is given:

1. Area, 2. Population, 3. Floristics, 4. Vegetation, 5. Checklists & Floras, 6. Field Guide, 7. Information — on threatened plants, 8. Botanic Gardens, 9. Laws of the country for protecting plants, 10. Voluntary organisation involved in conservation activities, 11. Useful addresses, 12. References.

Preface of the book expresses hopes that the information given in the book will encourage action to save the threatened plants assiduously documented by Botanists all over the world.

It also considers that, "Although more research is needed enough is known about the threats to plant life for action to be taken now".

We will all agree with the authors of this book that, "for of all the changes that man can make to the earth, none is more permanent or more wasteful than the extinction of a species".

The book is basically a reference volume and recommended for all libraries of Biological & Environmental disciplines.

M. R. ALMEIDA

2. COMMON FISHES OF INDIA. By B. F. Chhapgar. pp. 50 (24.5× 18 cm.) with four colour plates & 111 text-figures. @ World Wide Fund for Nature — India, Bombay, 1987. Oxford University Press. Price Rs. 20. [2nd edition to be published in 1989, Price Rs. 24/-].

Although wildlife is a popular topic today, very few people in India know enough to treat fishes as wildlife and as something more than a table delicacy. The reasons for this situation are not far to seek. Firstly, fishes being denizens of the underwater world, only 'Water babies' and scuba divers could observe them in their natural habitat. There is no fun in watching them in the fish market. Secondly, there is hardly any simple book on the fishes of India that can stimulate the common man to take interest in these unique creatures.

Dr Chhapgar's 'Common Fishes of India' published under the *Nature Guides* series of the WWF is an attempt to introduce some of the common or peculiar fishes that occur in the Indian waters, both inland and marine. The number of species described are barely 137 out of the several hundreds known in the Indian region. But this number is well within the scope of this 50 page book.

Most of the fishes included in the text are illustrated accurately in black and white or in colour. The fishes are grouped under natural taxonomic categories to make it more meaningful to a student as well as a lay reader. The description of each fish also includes a very brief but useful piece of information either on its habits or some other interesting peculiarity.

Within the constraints of space and cost of production it is a book worth its price and can be recommended not only for school and college libraries, but also for the bookshelf in the house.

ROBERT B. GRUBH

3. FLOWERS OF THE HIMALAYAS, a supplement. By Adam Stainton.

pp. i-xi + 72 (22 cm × 14 cm), with 128 coloured plates. Delhi, 1988. Oxford University Press. Price Rs. 225.00.

This book is a supplement to "Flowers of Himalayas" published in 1984, by the author jointly with Oleg Polunin. The supplement contains about 350 plant species not described in original volume and adds over 600 new coloured photographs of 584 species. Like the original volume, the supplement is intended for the lay reader and has been presented in simple language.

600 coloured photographs is definitely not a bad bargain for two hundred and twenty-five rupees and I am sure all lovers of natural beauty of our Himalayan flora would prefer to buy this supplement. Those who have the original volume of "Flowers of Himalayas" will certainly find their volume incomplete without this supplement.

The following errors are noticeable in the supplement:

1. Photograph no 98: *Caesalpinia cucullata.* Inflorescence in this photograph is that of the titled species whereas the leaves are of some different species, probably of *Woodfordia fruticosa.*

2. Photograph no. 336: This photograph named *Wrightia arborea* is wrongly identified. The plant shown in the photograph is known in our Indian Floras as *Holarrhena antidysenterica,* which has been corrected by Dr. K. M. Mathew in his "Flora of Tamil Nadu Carnatic".

M. R. ALMEIDA

MISCELLANEOUS NOTES

1. OCCURRENCE OF AN ALBINO RAT-TAILED BAT; *RHINOPOMA MICROPHYLLUM KINNEARI* WROUGHTON IN THE INDIAN DESERT

(*With a text-figure*)

Albino bats in some species, *Miniopterus schreibersii* (Kahrau 1972), *Myotis lucifugus* (Smith 1982), *Rousettus leschenaulti* (Karim 1983) (and for other species see Allen 1939) have already been reported but there is no such report in the case of *Rhinopoma microphyllum kinneari*; a common species of the Indian subcontinent.

During the present survey, a male albino of *R. m. kinneari* (Fig. 1) was collected from a bat colony situated below the elevated site of convocation ground of University of Jodhpur, India. This is probably the first report on the presence of albinism in this species.

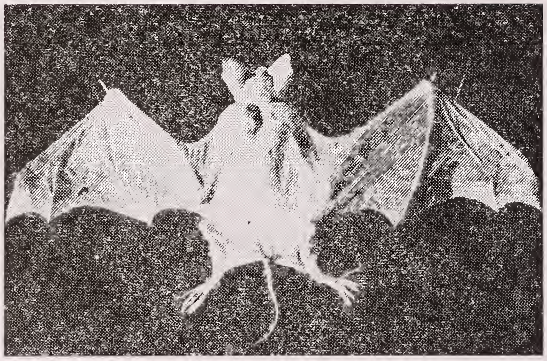

Fig. 1. Albino Rat-tailed bat, *Rhinopoma microphyllum kinneari* Wroughton.

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May 3, 1988.

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2. HABITAT SHARING BY HANUMAN LANGURS AND INDIAN FLYING FOXES

The eastern fringe of the great Indian desert at Jodhpur, Rajasthan harbours Indian flying fox, *Pteropus giganteus giganteus* Brünnich and Hanuman langur, *Presbytis entellus entellus* Dufrésne, which is also the extreme zoogeographic limit of their distribution in Thar desert (Prakash 1961, Roonwal and Mohnot 1977).

During our eco-ethological studies we have been observing a colony of *Pteropus giganteus* and one bisexual troop of *Presbytis entellus* roosting on a single Banyan tree (*Ficus bengalensis*) at Balsamand 12 km north of Jodhpur.

Their foraging time is different. Being nocturnal, the fruit bats leave their roost about 30 min. after sunset and return 45 min. prior to sunrise, whereas Hanuman langurs leave their roost about 15 min. before sunrise and return 15 min. after sunset and they spend very little time together and interact.

Two important questions arise from this observation — (1) why they have selected that particular tree, and (2) why this kind of close association occurs in nature.

The reasons of their selection of the banyan tree are:

1. The dense canopy provides protective covering for fruit bats from the scorching sunlight and cover from their predators.
2. Guttation provides coolness to habitants.
3. Flexible and strong branches help langurs for jumping and playing and fruit bats for hanging.
4. Fruits are consumed by both animal species so the tree gives feeding facility.

The possible explanations for their close association are —

(1) To maximise their natural resource (i.e. roosting site) potential.

(2) Utilisation of natural resource (i.e. feeding) and/or resource competition.

This kind of close inter-specific association is possibly because of a lack of alternate suitable roosting facilities.

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U. S. BHATI
ARUN SRIVASTAVA

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3. LEOPARD AND TIGER INTERACTIONS AT ROYAL CHITWAN NATIONAL PARK, NEPAL

Earlier studies in and adjacent to the park found evidence of high leopard mortality. Suitable habitat was not occupied for extended periods, suggesting that the population was experiencing difficulty replacing itself (Seidensticker *et al.* in press). Under certain conditions leopards succeed in co-existing with tigers, the former being socially subordinate to the latter (Seidensticker 1976). Nevertheless, leopards are not common in habitat where tiger density is high. They are most prevalent on the peripheries of the park, sandwiched between prime tiger habitat, on the one side, and cultivated village land on the other, dependent on both natural prey and domestic livestock. Tigers as well as humans contribute to leopard mortality.

During a period of 21 months, six leopard deaths were recorded. Although all occurred within 7 km^2, this does not represent the total area the leopards had used. Five were killed by tigers; the cause of death in the sixth case is unknown. In April, 1986 the remains of a subadult male, estimated to be 18 months old, were discovered in Sal forest at the foot of some hills. Wounds indicated that it had been killed by a tiger, the tracks of which were discovered nearby. Two months later, the decomposed carcass of a large leopard, presumed to be a male, was discovered in nearby riverine habitat; it was not possible to ascertain the cause of death. Ten months after the first leopard had been killed, a female leopard and her two small cubs were walking along a path through grassland near the Rapti River, on the edge of the park, when they were encountered by a tigress. The latter killed the mother leopard, dragged her body 75 metres, and devoured everything except the head and front paws. The two cubs escaped but returned the next night, when the tigress found and killed them not far from where she had fed on their mother. The leopard cubs were discovered seven metres apart, where they had been dragged in opposite directions by the two small (six months old) cubs of the tigress. The skulls of both, one a male and the other a female, weighing 5.7 and 5.2 kilograms respectively, had been crushed; their bodies were intact except for about half a kilogram of flesh which had been eaten from the hindquarters of each by the tiger cubs; the tail of one was also missing. During the next 11 months, when the resident female was not replaced, a large male leopard intermittently used the area. In January, 1988 his 4-5 day old remains were discovered in a patch of partially burnt grass. Canine punctures at the nape of the neck, the vertebrate of which were shattered, as well as wounds on the back, left no doubt that he had been killed by a tiger, most probably an adult female.

Two factors appear to have a bearing on the extermination of so many leopards by tigers in one area during a short period of time. First, subsequent to the establishment of the park in 1973 effective protection and good management have led to an increase in the prey base and a commensurate rise in tiger density. In a tract of western Chitwan of just under 100 km^2, including the smaller area where leopard mortality was recorded, the number of resident breeding adult tigers doubled from four to eight in the 11 years 1976-87. Secondly in this sector, very little peripheral habitat remains available for leopards. As human pressure inside the park has been largely eliminated by protection, it has increased outside, with consequent clearing of adjacent forest and scrubland. Now prime tiger habitat on one side of the Rapti River, the park boundary, faces open terrain with little cover on the other. These factors would increase the likelihood of confrontations between tigers and leopards.

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4. THE SMALL MONGOOSE FEEDING ON DROPPINGS OF NILGAI

On 23-iv-1988, while I was taking a census of peafowl in Roadside Plantation on S. H. 14 near village Tatarpur in Alwar District, I came across a small Indian mongoose (*Harpestes auropunctatus*) at 1800 hrs, which was wandering under ground cover in the plantation. I kept silent, hiding behind a tree trunk to observe the mongoose's activity. Soon it crossed the road and came towards me under the same *Acacia nilotica* tree whose trunk was serving me as a hide.

After some search, it came to a heap of droppings of Nilgai (*Boselaphus tragocamelus*) lying in the shade of the tree. Soon it picked up one pellet, holding it between its two fore-arms in a squirrel-like manner and completely ate it. While it was trying for a second feed, a motor cycle passed on the road which disturbed the animal and I could not watch further activity.

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SATISH KUMAR SHARMA

5. AERIAL FEEDING BY MEDIAN EGRET (*EGRETTA INTERMEDIA*), LITTLE EGRET (*EGRETTA GARZETTA*) AND POND HERON (*ARDEOLA GRAYII*)

During August and September, near most of the sluice gates of Keoladeo National Park, Bharatpur, I observed a strange feeding behaviour of egrets and pond herons. This is the time when the Irrigation Department supplies water to the Sanctuary from the Ajanbund reservoir. This year they started supplying water from 23rd July, 1985. Diagonally placed sluice gates regulate the flow of water into various blocks. Along with water, schools of fish fry also enter the Sanctuary. During this period, I observed the aerial feeding behaviour of the median egret, little egret and pond heron. The area where this behaviour was noticed was a clear sheet of fast flowing, deep, open water. Five to ten cm. long fish used to leap into the air, apparently throughout the day. Several dead and living Acacia trees, overhung this area. Almost every day, I saw about 20 to 25 egrets and pond herons congregated in this area, perching mostly on low branches near the water surface.

Every few minutes, four or five of them would take off and fly over the water surface in an attempt to catch the leaping, small fish. The flights were usually short and not more than 15 to 20 m long. All fish caught were taken to a perch before being eaten. Although several birds might be in the air at the same time, almost 90% of their attempts were successful. Sometimes, they were seen to make several attempts at catching fish during the flight before coming back to the perch.

This method of feeding has been described earlier for the little egret at Powai lake, Salsette, Bombay (Humayun Abdulali 1967), the little egret at Gorencheruva in Hyderabad (Rajeev Mathew 1983) and Indian pond heron at Parambikulam Wildlife Sanctuary, Kerala State by Grimwood and Brocklehurst (1984).

ACKNOWLEDGEMENTS

I thank Dr. V. S. Vijayan, Project Scientist and Dr. (Mrs.) Lalitha Vijayan, Senior Field Biologist, BNHS Ecological Research Centre, for their encouragement.

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6. AN INCIDENT OF A MALE NUKTA *SARKIDIORNIS MELANOTOS* (PENNANT) MOUNTING ON A SPOTBILL *ANAS POECILORHYNCHA* FORSTER

A rather uncommon congregation of resident ducks belonging to four species was observed during most days in June, 1986 in an open water area of the Keoladeo National Park at Bharatpur. On 17 June morning, most of the ducks in the congregation were observed resting and preening, except for a few which were swimming about feeding nearby. One of the swimming nuktas, a full-grown adult male was seen chasing a spotbill for a short time after which it mounted on the feeding duck's back. Mating posture was seen for just about a second. The nukta then moved off and the spotbill indulged in typical post-copulatory behaviour of bathing, wing-flapping and preening.

It is possible that such a behaviour is very rare, and could perhaps be interpreted more as bouts of abnormal leisure activity than anything else. However, this is the first instance of such aggressive mounting behaviour noted among Indian ducks.

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7. OBSERVATIONS ON THE UNUSUAL BEHAVIOUR OF IMPERIAL EAGLE (*AQUILA HELIACA*) IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

On the morning of 8 January, 1986, while we were punting through one of the jheels of Keoladeo National Park, Bharatpur, Rajasthan, I saw an adult imperial eagle (*Aquila heliaca*) sitting on a thick bed of grass, *Paspalum distichum*. From the feathers scattered all around, it appeared that it had preyed on a duck.

Seeing me approaching, the eagle tried to take to its wings, but it could not, probably because the wings and tail were soaking wet. The eagle flapped its wings and tried to run. It could not do so very fast because of the thick grass.

When I neared the eagle, it showed a peculiar behaviour. It lay on its back, with its legs upward and head down among the thick grass. The toes were held tightly and there was no movement and the bird appeared dead. When I touched the bird with a bamboo stick, it started pecking at the stick. This behaviour was observed continuously for 15 minutes. When I moved away, the bird got up, walked for a few metres and spread its wings and tail, probably for drying in the warmth of the sun and flew away after about 45 minutes.

This behaviour by the eagle was probably a desperate distraction display as it was unable to escape. Raptors are known to give threat displays when they are cornered (Brown 1976, Newton 1979). But behaviour as seen here is intriguing.

ACKNOWLEDGEMENTS

I thank Dr. V. S. Vijayan, Project Scientist and Mr. Vibhu Prakash, Research Biologist for encouraging me to write this note.

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8. LESSER SPOTTED EAGLE (*AQUILA POMARINA HASTATA*) NESTING IN KEOLADEO NATIONAL PARK, BHARATPUR

A nest of the lesser spotted eagle (*Aquila pomarina hastata*) was seen on 13th May, 1986 in the Keoladeo National Park.

The circular, flat, nest made mainly of *Acacia nilotica* and *Mitragyna parvifolia* twigs, was situated on the fork of a Kadam (*Mitragyna parvifolia*) tree at a height of *c.* 12 metres. The central depression was lined with fresh Jamun leaves and had a single, oval, white egg with prominent reddish speckling.

The eagles were brown all over and the conspicuous contrasting, very pale, underwing coverts and dark flight feathers were diagnostic of the species.

There is no recent breeding record of the species from anywhere in its range within the country. Ali and Ripley (1983) describe it as, "Comparatively rare, wherever it occurs viz. chiefly the gangetic plains east through Bihar, Bengal and Bangladesh, south to Madhya Pradesh". Abdulali and Panday (1978) describe it as, "resident and uncommon" at Bharatpur.

I thank Dr V. S. Vijayan for his help in the preparation of this note.

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9. INDIAN SCAVENGER VULTURE (*NEOPHRON PERCNOPTERUS GINGINIANUS*) FEEDING ON A DEAD WHITE-BACKED VULTURE (*GYPS BENGALENSIS*)

On the morning of 28th April, 1986, Drs. V. S. and Lalitha Vijayan reported seeing "a scavanger vulture feeding on a full grown but dead nestling of a white-backed vulture in the latter's nest in the Keoladhar area of Keoladeo National Park. The same evening, I too saw the remains of the dead vulture nestling, which was full of maggots and smelt strongly. Most of the flesh had been eaten by the maggots. The scavanger vulture was feeding probably on the putrid flesh which was still sticking to the bones or on the maggots.

Ali & Ripley (1983) describe its food as "carrion, offal and garbage and to a large extent human ordure. Occasionally takes frogs and large crickets on grasslands; in one case, *Brachytrypes achatimus* (Masan & Lefroy). Also winged termites emerging from the ground (C. F. Fischer).

Hence this behaviour of the scavanger vulture feeding on a dead nestling of white-backed vulture on the latter's nest is worth recording.

I am grateful to Dr. V. S. Vijayan for his encouragement.

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REFERENCE

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10. SOME OBSERVATIONS ON UNUSUAL FEEDING BEHAVIOUR OF WHITEBREASTED WATERHEN (*AMAURORNIS PHOENICURUS*)

The feeding behaviour of the White breasted Waterhen, one of the common monsoon visitors to Point Calimere (10°18′N, 79′51°E) was observed for seven days from Feb. 21-27, 1985 continuously in a small water pool found near the forest department quarters. Observations were made through one of the windows of the quarters, since the water pool was close to it. The drying water pool was partially covered by a small Prosopis tree (*Prosopis juliflora*) which was the regular roosting place for the bird during the observation period. Active feeding was observed late in the evening before the bird went for roosting. It fed mainly on shrimp and small fishes. It used to enter the water for catching fish and shrimp even up to the depth where the water used to touch its belly. Whenever it caught any shrimp, it crushed the prey between the mandibles before swallowing it. Occasionally it caught a small catfish of 3-4 cm. After catching the fish, the bird would hurry back to the land and many times I saw it dismembering the prey with the clear intention of dislodging the poisonous spines of the fish. Dismembered fish used to be brought again to the water for removal of sand particles. The fish was cleaned by holding it in the beak, then dipping it into the water and vigorously shaking it. On two occasions the poisonous spines of the catfish were collected by me after the bird had left the place. After the pool dried up, the bird changed its roosting place and was not seen again near the quarters.

According to Ali & Ripley (1969) the food of the White breasted Waterhen is insects and their larvae, molluscs, worms, seeds and shoots of marsh plants. I think small fish and shrimp should be included in the diet of this bird.

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11. FORAGING-RELATED CHANGE IN FOREHEAD COLOUR IN KENTISH PLOVER (*CHARADRIUS ALEXANDRINUS*)

A solitary Kentish Plover in winter plumage observed at Kihim beach (Raigad District) on 30 August, 1986 revealed a behaviour pattern that may be adaptive for greater efficiency in capturing prey. It was seen that the extent of white on the birds' forehead, affected by the sudden erection of feathers on that part, increased abruptly when the bird stopped to collect a morsel while foraging. The 'normal' extent of white on the forehead while the bird is at rest, or moving about in a non-feeding activity is restricted to a thin line just above the bill which extends backwards to meet the fore-edge of the eyes and more apparent in specimens is "continued unbroken as backwards as supercilium" (IND. HB. 2: 235). While engaged in foraging, the bird takes several mincing steps, often running in a zig-zag pattern; in doing this, it suddenly brakes to a stop to either 'collect' an insect on the sand surface or to probe the sand for a worm. It is at this stage, just a fraction of a second before it stops, that the feathers on the forehead are erected, revealing a large flash of pure white which extends up to the fore-crown. Once or twice in a sequence of seven or eight such observations between 0740 and 0755 hrs., the upper edge of the white band appeared to be mottled with brown.

The plover was the only visible bird on the beach, except for a brief visit of one Brahminy Kite and two Pariah Kites (*Haliastur indus* and *Milvus migrans*) skimming over the Casuarina treetops *c.* 100 metres away. All the observations, made from 12-15 metres away with 10×40 binoculars, involved the bird directly or obliquely facing the sun which was just clearing the top of the Casuarina trees. The bird was feeding at the water's edge in an incoming tide, and was facing downwind in all the observations, which rules out the possibility of the feathers being ruffled by the wind.

This behaviour may be analogous to the 'open-wing' (? wing-flashing) foraging pattern of several heron species (Ardeidae), wherein they create a shadow on the water's surface, thus attracting fish to the surface. It is however not clear how a sudden flash of white on the plover's forehead could make a worm or insect more vulnerable. On explanation suggested by Carl D'Souza, bird artist, is the possibility of the white patch having a reflective value when the bird is facing the Sun, a situation when its prey — or the entrance to the worms' tubular hole — would be in shadow. This shadow may then, to some degree be illuminated by the birds' white feathers with the Sun reflecting of them.

Examination of specimens shows that the white feathers on the forehead of this species are much smaller and softer, and easily erected. Additional observations on a larger sample of birds in different habitats (mudflats, far from the water-line etc.) and in different lighting conditions may throw some light on this behaviour pattern.

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12. BROWN-HEADED GULL, *LARUS BRUNNICEPHALUS* IN IRAQ — A CORRECTION

The Brown-headed Gull *Larus brunnicephalus* breeds "on inland lakes of the high plateaus of central Asia from Chinese Turkestan to southern Mongolia and south to Ladakh and the eastern Himalayas" (Peters 1934). It winters mainly along the coasts of the Indian subcontinent, eastwards to Peninsular Malaysia, Thailand and Vietnam, with small numbers occurring as far east as Hong Kong (Vaurie 1965, Melville 1977). The first record of the species from the Middle East was of a single bird caught at Aden reported by Barnes (1893), who also recorded two birds shot. Meinertzhagen (1954) noted that there was "much doubt about the correctness of identification". The only other record from the Middle East was by Abdulali (1970), who noted an adult from Sheik Saad, Iraq in the collection of the Bombay Natural History Society.

While examining skins in the BNHS collection, I came across this specimen (No. 14150), which is, in fact, an adult Common Gull *Larus canus.* The prepared museum skin resembles an adult Brown-headed Gull in non-breeding plumage and it was not until I carefully examined the primary patterning that I realised that it was a Common Gull. Both species have strongly marked white mirrors on the black part of the outer primaries, but in the Brown-headed Gull there is a broad white bar across the inner part of the primaries and coverts, whereas in the Common Gull the rest of the wing is grey. The bill of the Common Gull is also proportionately shorter and stouter than in the Brown-headed Gull. In the flesh, adults of these two species are easily separated by the colour of the legs and bill — greenish yellow in the Common Gull, but blood red in the Brown-headed Gull.

The specimen in question, a female, was collected at Sheik Saad, River Tigris (approx. 32°30′N, 46°20′E) on 10 February, 1917 by P. Z. Cox & R. E. Cheesman. It is presumably the same bird as that reported (as a Common Gull) by Ticehurst *et al.* (1922), who noted that the species was "A fairly common winter visitor [to Mesopotamia], more particularly perhaps to the river [Tigris] from Sheik Saad downwards. Buxton did not observe it before December and it remained common at Amara till the end of March, when it left suddenly".

D. A. Scott (personal communication) informed me that there are sight records of two Brown-headed Gulls from Chahbahar and one from Hamun-i Puzak, near Takhte-Shah, in eastern Iran. The only other record from the Middle East which I am aware of, is one at Eilat, Israel in 1985 (H. Shirihai, personal communication).

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Acknowledgements

I am grateful to Dr Salim Ali and S. A. Hussain for inviting me to join the BNHS Avifauna Project team and to Mr. Humayun Abdulali for his assistance and comments. D. A. Scott and H. Shirihai kindly made available their records from Iran and Israel respectively.

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13. KESSLER'S THRUSH (*TURDUS KESSLERI*) FROM NEPAL

On the afternoon of 26th January, 1986 I was birdwatching in the hills above Namche Bazaar, Everest trek (3,446 m), Nepal.

In a rocky area of alpine scrub vegetation I came across a mixed flock of birds which included the following species: Red-throated and black-throated thrush (*Turdus ruficollis*), Alpine Accentor (*Prunella collaris*), and White-winged Grosbeak (*Mycerobas carnipes*). My attention was drawn to another Thrush (*Turdus* sp.) feeding on the ground amongst the others. Although I was at close range to the flock. I only obtained partial views of this bird. However, I received a general impression as follows. A strikingly coloured Thrush, similar in size to Red-throated Thrush. Three contrasting colours were apparent; a black head and nape, fawn bands across the breast and upper back; tan underparts and lower back.

No identification was made by me at this point as I could find nothing similar in Fleming's BIRDS OF NEPAL. However, my attention now drawn by the description of Kessler's Thrush as a 'large black and tan thrush'.

Low cloud descended and I was forced to return to Namche bazaar with no satisfactory views. Subsequent searching the following day did not relocate the bird although large numbers of Red-throated/Black-throated thrushes were still in the area.

Eight days later trekking north from Namche Bazaar towards Gokyo I came across the same species. On this occasion there were two male thrushes with a flock of approximately twelve Eurasian Blackbird (*Turdus merula*), again on rocky slopes with sparse alpine vegetation. On my descent from Gokyo to Namche I again saw these birds in the company of up to seventeen Eurasian Blackbird. On this occasion there were 3-4 male thrush and one female bird. They were seen both in scrub and in Juniper (?) trees.

The precise areas in which I saw these birds were 1/3rd February 1986 north of Lhabarma (4328 m) on rocky scrub covered slopes, 2/5th February 1986 in Juniper bushes/trees south of Gyele (4084 m).

Note: Map references and heights refer to the 1985/6 Mandala productions trekking map "Lamosargu to Mt. Everest and Solu-khumbu".

On the second occasion the birds were seen at a distance of 10 metres in good light using zeiss 8 × 30 binoculars.

I took the following field notes:

Size and structure: Identical in size and structure to Eurasian Blackbird, with which they could be directly compared as both species fed in the same bush.

Plumage Head: Entire head black, extending to the upper mandible above and to the upper breast below.

Underparts: A fawn band, similar in thickness to that of a Ring Ouzel (*Turdus torquatus*) separated the black upper breast from the belly. This band tapered to a point at the wing joint. The belly, flanks, vent and undertail coverts were rich tan.

Upperparts: A few band separated the upper mandible from the lower mandible. It too, tapered to a point at the wing joint, but did not join the fawn breast band. The mandible below this band was rich tan as was the rump. The tail and wings were entirely black.

Bare parts: Bill yellow. The leg colour was not noted.

The female bird had the same patterning but black areas were replaced by grey-brown and tan areas by pale brown. The fawn separating bands were still apparent but were not at all striking as was the case with the male birds.

The birds were studied for about ten minutes.

The weather on each of the three occasions was not exceptional, atleast it was not unusually cold for the time of year. I do not have any statistics for the earlier part of the winter which may account for the arrival of this species (and for that of the Eurasian Blackbird) but I did receive reports that December had been 'severe' in the high Himalayas.

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14. PRESENCE OF FRUIT OF *XANTHIUM STRUMARIUM* IN THE NEST OF *PLOCEUS PHILIPPINUS*

On August 21, 1984 at Tatar Pur Mixed Plantation 'A' (Alwar, Rajasthan) when I was watching a colony of *Ploceus philippinus* situated on a tree of *Prosopis spicigera,* I came across a completed blind nest having closed entrance tube. I removed the nest from the tree and examined its inside, bisecting it into two halves with scissors. I was surprised to see an old fruit of *Xanthium strumarium* inside the egg-chamber. A little search showed an uprooted old plant of *X. strumarium* in the vicinity of the host tree. Perhaps the fruit was taken from that plant.

The nest had been rejected due to an unknown cause. The presence of such fruits is quite abnormal. Mud, cowdung and floral parts of certain plants have been reported earlier from the nests of baya but not fruits of *X. strumarium.*

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15. OBSERVATIONS ON SOME SNAKE-EATING BIRDS OF THE CHILKA LAGOON, ORISSA

In the course of a herpetofauna survey conducted recently in and around the Chilka lagoon by the Zoological Survey of India, we had the opportunity to observe some ophiophagous birds while they were actually preying upon snakes, live and dead.

In the first instance we saw at Maltikuda Island, off Barkul, a White-bellied Sea Eagle (*Haliaeetus leucogaster*) beating a large sized Wart Snake (*Acrochordus granulatus*) to death on a rock and tearing its flesh with the beak. By the time we reached the spot the bird flew away after having partially eaten the helpless snake. Besides wart snake, some other snakes like the Dog-faced Water Snake (*Cerberus rhynchops*) and the estuarine hydrophid (*Hydrophis obscurus*) found in the lake seem to be taken by the birds as evidenced by the presence of several dead and partially cut-open specimens of these species scattered all over the tiny island. In another instance recorded recently on the margin of the lake near Rambha, two house crows (*Corvus splendens*) were found eating a dead Dog-faced Water Snake. When the snake was picked up later and examined, it was found that the birds had fed upon the snake's slender neck and portions of the belly.

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16. NOTES ON CROCODILIAN LOCOMOTION

(*With a photograph*)

1. Gharial (*Gavialis gangeticus*)

While the gharial is one of the most thoroughly aquatic crocodiles, it is capable of considerable overland movement. At the Madras Crocodile Bank, a sub-adult male of 2.3 metres length did a belly slide of 650 metres one night after climbing its 120 cm pen wall. While the belly slide is the only terrestrial gait gharial over 2 metres seem capable of, smaller specimens are able to support themselves and walk in spite of their somewhat feeble front legs, though they usually do not, and employ the raised posture primarily as a threat display.

In Corbett National Park and at Madras Crocodile Bank, submerged gharial were frequently observed to propel themselves quickly along through shallow water by pushing their feet along the bottom with a gait reminiscent of the varanid gait (the body swings, while the head remains relatively stationary as it moves forward).

When crocodilians thus move along muddy bottoms, their progress is often visible by trails of bubbles. Pond gas is released as their feet touch the bottom, and we have, several times, detected the presence of crocodiles in ponds and streams in the wild by this observation.

2. Galloping in the Mugger Crocodile (*Crocodylus palustris*)

In their paper on galloping in *Crocodylus johnstoni*, Webb and Gans (1982) describe the bounding gait termed galloping that is frequently used by this rather diminutive Australian crocodile to escape capture or when released. They conclude that it is a useful gait to increase escape velocity and to negotiate rocks and logs in the way, especially for crocodiles which spend considerable time travelling or hunting on land.

While working on the United Nations crocodile project in Papua New Guinea, the first author observed galloping by the New Guinea crocodile on numerous occasions (though never *Crocodylus porosus* as reported and filmed by Zug 1974). While this gait was more commonly used by younger animals and then always to escape (as Webb and Gans also report), a captive adult female of *c.* 1.65 cm (TL) at Moitaka Farm used to rush to defend her nest by galloping up a fairly steep slope. (See Photo. 1, taken in the wild in Papua New Guinea). Bustard and Singh (1977) report galloping in young *Gavialis,* and in 1981 the first author saw young *Osteolaemus tetraspis* gallop at Zoo Negara in Malaysia (Whitaker 1981).

We have observed juvenile *Crocodylus palustris* galloping on a number of occasions. The mugger is one of the species of crocodiles that is regularly reported to hunt on land and routinely makes long seasonal forays between bodies of water. Though mugger which we have encountered far from water in the wild made no attempt to escape, much less gallop, there are obviously circumstances (such as a refuge in water nearby) when this spectacular gait would be employed.

The reader is referred to the paper by Webb and Gans for a statistical analysis of galloping and a discussion of the other crocodilian gaits.

ACKNOWLEDGEMENT

We wish to thank Romaine Andrews for typing the manuscript.

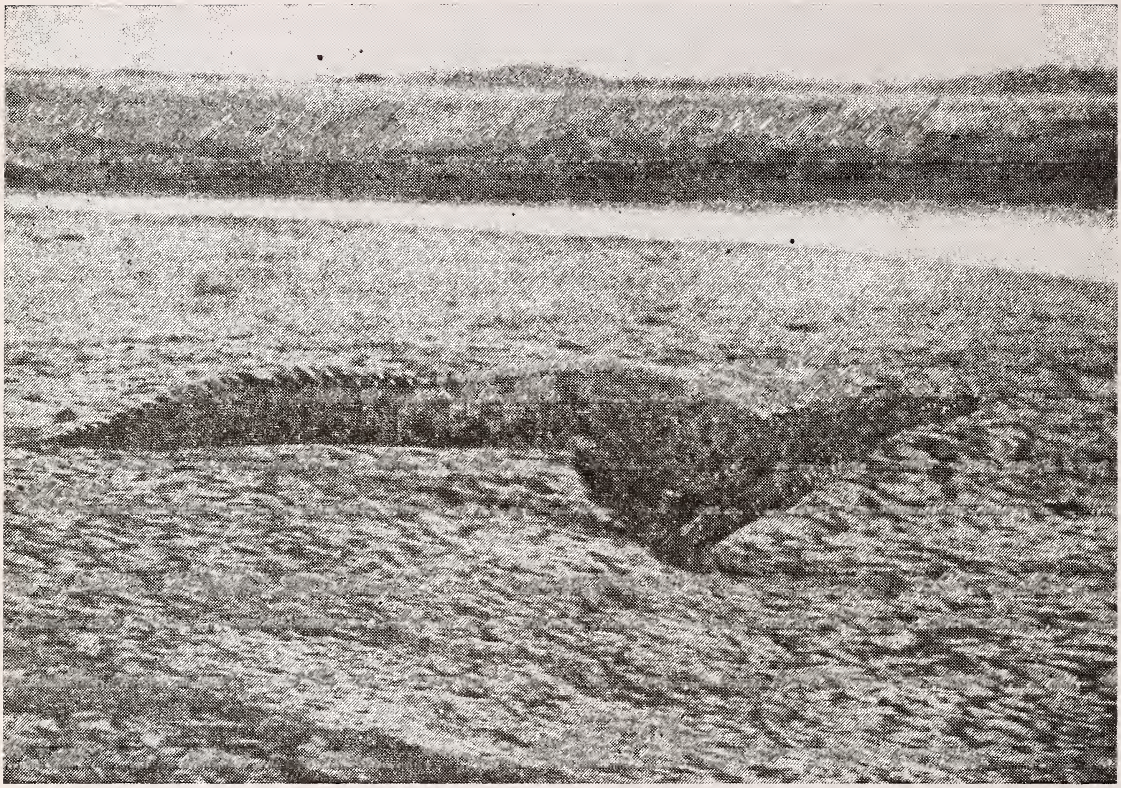

Photo. 1. Sub-adult New Guinea Crocodile galloping. (*Photo*: Bob Hawkins).

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ROMULUS WHITAKER
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17. A NEW RECORD OF THE ASSAM ROOFED TURTLE *KACHUGA SYLHETENSIS* (JERDON) FROM THE MANAS WILDLIFE SANCTUARY, ASSAM

Since little is known about the turtles of Manas Wildlife Sanctuary, we are maintaining a small collection of live turtles at Bansbari range office. On 24 December, 1987, I, along with some forest guards had been on a routine patrol in the Uchila-Rabang areas of the sanctuary. While looking for turtles in a small river, we came across an unusual variety of turtle which was later identified as the Assam Roofed Turtle or Khasi Hill Terrapin *Kachuga sylhetensis* (Jerdon). Daniel (1983) has mentioned that this uncommon species is known only from the hills of Meghalaya and Nagaland and its habits are unknown. According to Das (1985) it is also found in Cachar Hills of Assam and extralimitally in Bangladesh. He writes that it probably lives in ponds and hill streams and it is a rare species with no recent record from the country.

Location and Habitat: The specimen was found in the shallow waters of Rupahi river (a tributary of river Pohumara) in the Manas Wildlife Sanctuary. The water level at the site was approximately 35 cm. and it was full of debris from uprooted trees. The Rupahi river passes through grassland plain (elevation approx. 60 m. above MSL) with few trees along its bank.

Description: Carapace domed or elevated with the third vertebral shield forming a projecting spike. Thirteen pairs of marginal shields give a strongly serrated look to the posterior end of the carapace. Shell olive-brown above with paler keel. Plastron yellow with each shield having a large dark brown blotch. Digits fully webbed. Head and legs brown with a yellow wavy stripe along the head and another along the lower jaw. Neck with light streaks. Shell length 89.5 mm, breadth 66.5 mm. Weight 93.5 g.

Notes on Behaviour in Captivity: The turtle has been kept in a large, well ventilated enclosure with some natural grassland vegetation growing inside. A man-made mound with a hole and a small pool are also provided. The turtle usually hides among the vegetation or in the bottom of the pool or even in the hole during daytime. It can swim very well and remains under water without surfacing for several minutes.

It is a voracious feeder of tiny freshwater fish offered to it on the ground. It prefers the softer ones and shuns varieties with hard or sharp external spines. It generally eats at night. It does not touch the ripe fruits (peeled banana and papaya) or tender wheat and grass shoots.

ACKNOWLEDGEMENTS

I thank Messrs Mon Mohan Nath, Bhaben Chandra Deka and Naren Medhi, all game watchers at Manas Wildlife Sanctuary, for their assistance.

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18. ON THE INDENTITY AND OCCURRENCE OF THE PEACOCK SOFT-SHELL (*TRIONYX HURUM* GRAY) IN RAJASTHAN

On 23 August, 1986 while sampling the fishes in Keoladeo National Park, Bharatpur, we got a turtle along with the fishes, which was later identified as peacock soft-shell (*Trionyx hurum*).

Subsequently twenty specimens of this species were collected and the morphological features were recorded. As described elsewhere (Smith 1933, Pritchard 1979, Daniel 1983), this soft-shell had dark olive green to black carapace with numerous yellow spots and blotches. Young ones had well defined ocelli on the carapace and the plastron was grey. The head was olive green with numerous yellow spots with a more prominent one behind the eyes.

The species differed from the Ganges soft-shell (*Trionyx gangeticus*) in its dark carapace, four well defined ocelli and grey plastron in the young, black eyes (yellow or white cornea in Ganges soft-shell), wart-like tubercles in the posterior end of the mid dorsal line of the bony carapace, and the presence of yellow spots in the head. (three oblique black lines behind the eyes in Ganges soft-shell).

Until the recent past, the known range of peacock soft-shell was the lower reaches of Ganges and Brahmaputra (Smith 1933, Pritchard 1979, Daniel 1983, Murthy 1985). Recently this species has been recorded from Pune region (Varghese and Tonapi 1986) and from Bhopal (Indraneil Das, personal communication) which are far away from its previously known range. This is the first record from Rajasthan. An intensive survey is required to ascertain the status and possible distribution of this elegant turtle.

We are thankful to Dr. V. S. Vijayan, Project Scientist, BNHS Ecological Research Centre, Bharatpur for his encouragement.

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19. THE ARTIFICIAL INCUBATION OF EGGS OF THE COMMON CAT SNAKE *BOIGA TRIGONATA* (SCHNEIDER)

The Indian Gamma or Cat Snake *Boiga trigonata* (Schneider) is very common in Gujarat State; local people know it as 'Mindadiya Sap' or 'Padaka'. A 87.5 cm long gravid female was captured on 9th July, 1986 from Harni area of Baroda city. Since limited information is available on the breeding habits of this species, it was kept for observation.

Background: The available literature gives the following information on the breeding habits of the Cat snake.

(1) M. A. Smith (1943) — 3 to 11 eggs are laid, the young when born measure between 23.7 and 26.0 mm. in length.
(2) R. Whitaker (1978) — A cat snake at the Madras Snake Park laid seven eggs in October and the length of the newborn young was 25.0 cm.
(3) J. C. Daniel (1983) — Gravid females have been obtained from May to August and eggs in September. Three to 11 eggs are laid, measuring 30 × 10 mm. Hatchlings have been obtained in March and July.

Details of the breeding: The female Cat snake laid nine eggs in a wooden box at night on 18th July, 1986. The eggs formed a compact agglutinated mass, and were long, oval and white with little variation in size. The measurements are given in Table 1.

Incubation: The following method of artificial incubation was followed, which has proved successful with snake and lizard eggs.

The egg mass was removed from the wooden box and transferred to a transparent polythene bag with a substrate of moist cottonwool. The eggs were not directly put on moist cottonwool but on a piece of polythene bag. The bag was inflated and closed tightly with a rubber band. It was then placed in a wooden box with ventilation at room temperature. The temperature varied from 18°C to 34°C. The eggs were inspected every day, and whenever any of them was dented, water was added to the cottonwool substrate. (Here the maintenance of correct humidity is vital). The polythene bag was inflated whenever necessary and the substrate was removed whenever it was noticed to be infected by fungi.

Table 1

Measurements of the five fertile eggs and resultant hatchlings of *Boiga trigonata* (in cm.)

No.	Diameter of eggs	Length of eggs	Body length of young	Length of tail
1	1.3	3.2	25.5	5.0
2	1.1	3.1	25.5	5.3
3	1.2	3.3	25.7	5.1
4	1.0	2.9	25.0	4.9
5	1.1	3.0	25.0	4.8
Average	1.1	3.1	25.2	5.2

Hatching: Five eggs (55%) out of the total of nine proved to be infertile and some were lost due to fungal infection. The five fertile eggs hatched on the 3rd September after an incubation period of 48 days.

All the young were alert and very active. They exhibited identical body colour and pattern. Dorsal body colour was light brown with a series of 35 to 46 V-shaped zigzag markings. The top of the head had a clear "Y" mark in one snake but the head marks was totally different, having a dark streak from behind the eye. The Belly colour was tan with a small black spot on the outer margin of each ventral.

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20. ADDENDA TO THE AMPHIBIAN FAUNA OF INDIA

Recently Inger and Datta published [*J. Bombay nat. Hist. Soc.*, 83 (Supplement) Centenary issue (1886-1986)] "An overview of the amphibian fauna of India". We have noted that 13 valid species of Indian amphibians (Anura) have not been incorporated in the list. In order to make the list up to date, the names of the species including type localities and their known occurrence in the Indian States are given below.

Taxonomic list	Type locality	Records in Indian States
ANURA		
PELOBATIDAE		
1 *Megophrys kempii* (Annandale, 1912)	Upper Rotung Arunachal Pradesh	Arunachal Pradesh (Annandale, 1912)
BUFONIDAE:		
2 *Bufo sulphureus* Grandison & Daniel, 1964	Satara district, Maharashtra	Maharashtra (Grandison & Daniel, 1964)
RANIDAE:		
3 *Nyctibatrachus pygmaeus* (Gunther, 1875)	Anamalai Hills	Tamil Nadu (Gunther, 1875)
4 *Nannobatrachus annamallaiensis* Myers, 1942	Anamalai Hills	Tamil Nadu (Myers, 1942)
5 *Micrixalus herrei* Myers, 1942	Kallar	Kerala, (Myers, 1942)
6 *Rana bhagmandlensis* Rao, 1922	Coorg	Karnataka (Rao, 1922)
7 *Rana erythraea* (Schlegel, 1837)	Java	Assam (Boulenger, 1920), Orissa (Mohanti-Hejmadi, 1974), Meghalaya, Mizoram (Chanda, 1986)
8 *Rana kuhlii* Tschudi, 1838	Java	Assam (Boulenger, 1920)
9 *Rana nigrovittata* (Blyth, 1855)	Burma	Assam (Boulenger, 1920)
10 *Rana sinchalensis* Chanda, 1986	Darjeeling	West Bengal (Chanda, 1986)
RHACOPHORIDAE:		
11 *Philautus argus* (Annandale, 1912)	Arunachal Pradesh	Arunachal Pradesh (Annandale, 1912)
12 *Philautus longicrus* Rao, 1937	Kempholey	Karnataka (Rao, 1937)
13 *Philautus montanus* Rao, 1937	Kempholey	Karnataka (Rao, 1937)

Remarks on Nos. 12, 13

It may be noted that Rao [1937, *Proc. Indian Acad. Sci.*, B (6)], described *longicrus* (p. 414) and *montanus* (p. 415) from Karnataka but both these specific names are preoccupied by *P. longicrus* (Boulenger, 1894) and *P. montanus* (Taylor, 1920). However, as the type material of Rao (op. cit.) deposited in the Central College, Bangalore are reported to have been lost and as the type localities of Boulenger's (op. cit.) and Taylor's (op. cit.) are in Philippines, it is difficult to ascertain whether the Indian specimens belong to the same species as those from Philippines. It is also impossible provide a new name for Rao's (op. cit.) species at this stage till topotypes could be collected and compared with the Philippine material.

ZOOLOGICAL SURVEY OF INDIA,
27, J. L. NEHRU ROAD,
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November 19, 1987.

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21. A NOTE ON THE MORPHOMETRY OF *RHACOPHORUS MALABARICUS*, THE MALABAR GLIDING FROG

On June, 1987, I had an opportunity to go to Goa for collecting frogs, especially the Malabar gliding frog. With the help of the forest department, I reached the moist deciduous forest near Volpoi town, at about 6.30 p.m. The monsoon season had already started and there was a good rain. I knew the habitat of the frogs and there was no difficulty in

TABLE 1

MEASUREMENTS OF FOURTEEN ADULT MALES AND ONE ADULT FEMALE (IN PARENTHESIS) OF *Rhacophorus malabaricus*

Measurements	Range	Mean	Sd±	Ratio to body length %
Body length	58.0-67.0	62.43(78.5)	3.16	—
Head length	17.0-19.0	18.28(24.0)	0.72	29.28(30.57)
Head Width	18.0-21.0	19.14(28.5)	1.04	30.66(36.31)
Internasal space	4.5-5.5	5.04(6.5)	0.26	8.07(8.28)
Interorbital space	6.25-8.25	7.00(10.0)	0.60	11.21(12.73)
Width of Upper eyelid	4.5-6.5	5.38(7.0)	0.38	8.62(8.92)
Tympanum	4.0-5.0	4.16(5.5)	0.28	6.66(7.0)
Arm Length	31.0-41.5	36.21(47.0)	3.43	58.00(59.87)
Diameter of lower arm	4.0-6.75	5.41(8.75)	0.84	8.67(11.15)
Hand length	18.0-21.0	19.0(25.5)	0.83	30.43(32.48)
Leg length	84.5-105.0	98.43(137.0)	5.86	157.66(174.52)
Tibia length	27.5-34.0	31.68(43.0)	1.96	50.74(54.77)
Length of foot and tarsus	38.5-46.5	44.11(63.0)	2.09	70.66(80.25)
Foot length	27.5-32.0	30.36(40.5)	1.68	48.63(51.59)
Inner metatarsal	2.75-4.5	3.16(7.0)	0.43	5.06(8.92)
Width of toe pad	3.0-4.5	3.52(7.5)	0.40	5.64(9.55)

* All measurements in millimetres.

locating them. More than fifty males were seen calling, while sitting on bamboo shoots. One pair was seen in amplexus. The male, which was smaller in size, held the larger female, at her armpits. They did not produce any foam nest.

The measurements of fourteen adult males and the single adult female collected are given in Table 1. The maximum size of the male was 67 mm snout-vent length (SV). The female was 78.5 mm SV. Ayyangar (1915) recorded a SV length of 2½ inches (82.5 mm) of a single, unsexed, preserved specimen collected from Malnad forest region, some twenty miles from Gersoppa Falls in Karnataka. Inger *et al.* (1984) who made a collection of this frog from Ponmudi hills measured eight adult males 61.9-73.5 mm SV, mean 68.8 and one adult female 95.8 mm. It seems that the size differs according to locality.

BOMBAY NATURAL HISTORY SOCIETY,
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BOMBAY - 400 023,
March 8, 1988.

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22. RARE OCCURRENCE OF SUNFISH *MOLA MOLA* (LINNAEUS) FROM THE COASTAL WATERS OFF VISAKHAPATNAM (BAY OF BENGAL)

(*With a photograph*)

The occurrence of sunfish in any sea is a rare event. It is so rare that even fishermen engaged in fishing throughout their lives find it totally strange when they come across one. On 6 May, 1986, a local fisherman reported to the Zoology Department of the Andhra University that a very strange looking fish was part of that day's catch. The local fisherman community had not seen the likes of it ever before. It turned out to be a sunfish, more specifically, *Mola mola.*

The occurrence of *M. mola* was first recorded in Indian waters by Khan (1975) from the Arabian Sea, near the Bombay coast. Earlier, Deraniyagala (1944) recorded one specimen from Ceylon (Sri Lanka) waters. There were some other reports of the occurrence of allied species (*Ranzania, Masturus*) of Molidae from the Arabian Sea by Kulkarni (1953), Chhapgar (1964) and Khan (1975). So far, *M. mola* has not been reported from the Bay of Bengal and the present finding is a matter of biological significance.

DESCRIPTION OF THE FISH

Morphometric characters:	
Total length	912 mm
Standard (preclaval) length	730 mm
Body depth	632 mm
Head length	280 mm
Eye diameter	55 mm
Snout length	130 mm
Length from tip of snout to origin of dorsal fin	630 mm
Length from tip of snout to origin of anal fin	640 mm
Length of dorsal fin	490 mm
Length of anal fin	480 mm
Length of pectoral fin	130 mm
Length from tip of dorsal fin to tip of anal fin	1350 mm
Vent diameter	40 mm
Length of gill opening	60 mm
Meristic characters:	
Dorsal fin rays	15
Anal fin rays	13
Pectoral fin rays	12

The clavus was too thick to count the caudal fin rays.

Identity of the fish. The fish had all the characters of *M. mola.* The body was typically truncate without a caudal peduncle. It was laterally compressed with high dorsal and anal fins being situated far behind on the body. Pectoral fins were small and situated at the middle on the sides of the body behind the head. Pelvic fins were absent. Colour of the body was grey with silvery shade on the ventral side and dark shade on the dorsal side and fins (Photo. 1).

Very little is known about the life of sunfishes. There are some general accounts which state that they are oceanic and epipelagic. The inference was drawn because of the usual sighting of these fish basking in the surface waters, far away from the coast. It is possible that such basking fish are ill, riddled with parasites (Harbison 1987) or old. Young fish were found to be "active and alert" (Fraser-Bruner 1951). Harbison (loc. cit.) and his team of workers observed the swimming behaviour of *Masturus lanceolatus* (Molidae) at close quarters at a depth of 670 m. The graceful sculling movements of the fish at that depth, where they were more common than at the surface, and the relationship with certain type of food organisms like ctenophores and medusae, show that the natural habitat of the fish is meso-

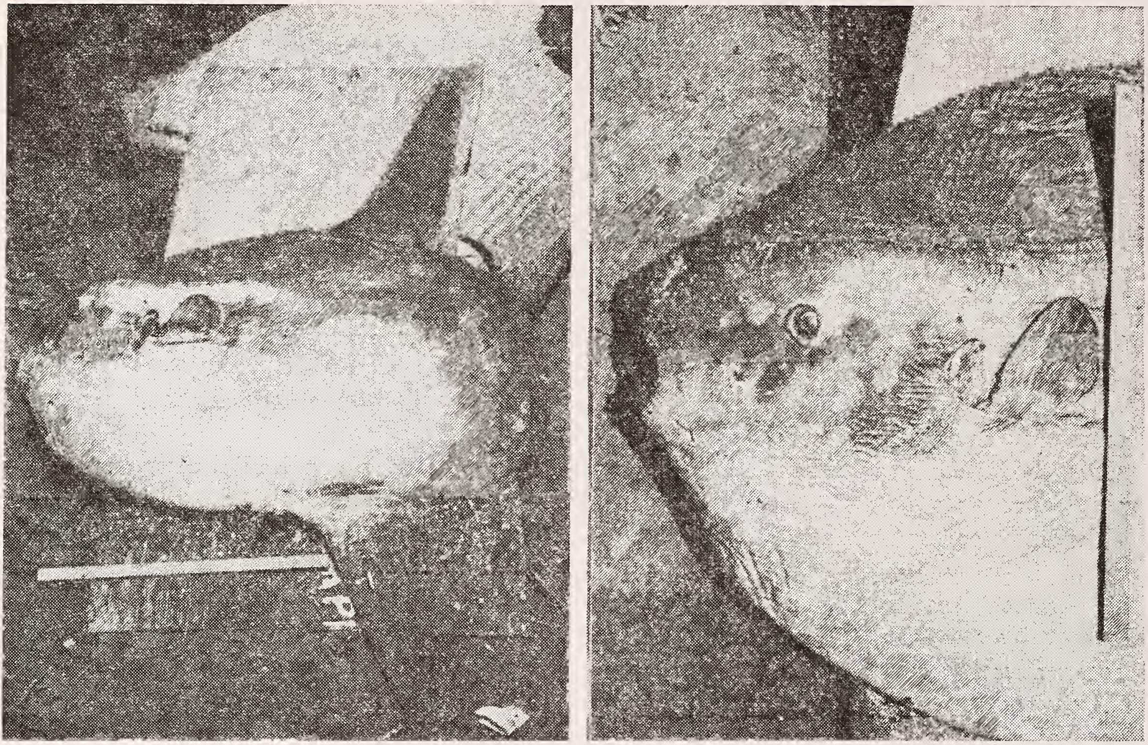

Photo. 1. Sunfish *Mola mola* (L.)
Left: Entire fish; *Right*: Anterior region enlarged (Scale = 500 mm).
(*Photos*: B. Ram Bhaskar)

pelagic rather than epipelagic. Similarly *M. mola* was found to descend to a depth of 180 m (Harbison, loc. cit.).

The present specimen was also caught at a depth of about 200 m as reported by the fishermen. It was an unusual sight for the fishermen because they seldom cast their gear in such deep waters. Even on the few occasions when they do deep-sea fishing, the chances of a sunfish getting caught in their deep water gear (usually hook and line) are almost nil because of the alertness of the fish. These fish may be present in the mesopelagic relgons in considerable numbers but they are not well known because of negligible fishing in the region and that too by hook and line only, which may not catch the fish. It is not because they are not there but because we do not have the gear to catch them at such depths, that their appearance is such a rare event.

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23. A NOTE ON THE ICHTHYOFAUNA OF SANJAY GANDHI NATIONAL PARK, BORIVLI, BOMBAY

(*With a text-figure*)

Among the four National Parks in the State of Maharashtra, Sanjay Gandhi National Park (SGNP) stands out as a beautifully preserved green oasis within the confines of the metropolitan city of Bombay. The Park (Fig. 1) covers an area of about 96.40 sq. km. and lies between longitude 72′53° and 72′50° E and latitude 19′88° and 19′21° N. The southern boundary of the park is formed by the shore of Vihar lake, on the east by the townships of Bhandup, Mulund and Thane, and on the west by Goregaon, Malad, Kandivli and Borivli. The park area extends beyond Bassein creek in the north and includes the Nagla forest block.

Although the flora and terrestrial fauna of this park have been studied (Naik 1986, Monga 1986) no published record of the fishes from this area is available. Hence a survey was conducted to assess the fish fauna present in the various lentic and lotic waters of this park.

The water resources of SGNP

The major sources of water in the park are:

Lentic — Tulsi lake
Vihar lake
Lotic — Dahisar river
Rewat nallah

Tulsi and Vihar lakes are two impoundments which supply water to Bombay city. The catchment area of Tulsi is about 745.25 ha

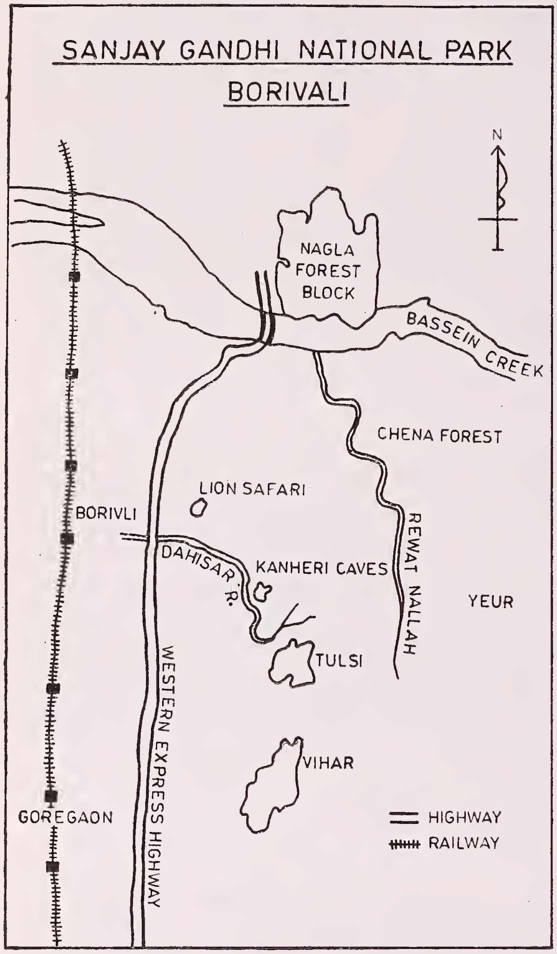
SANJAY GANDHI NATIONAL PARK
BORIVALI
N
NAGLA FOREST BLOCK
BASSEIN CREEK
CHENA FOREST
LION SAFARI
BORIVLI
DAHISAR R.
KANHERI CAVES
REWAT NALLAH
YEUR
TULSI
WESTERN EXPRESS HIGHWAY
VIHAR
GOREGAON
HIGHWAY
RAILWAY

Fig. 1.

while the actual water spread is 130.918 ha. Vihar lake covers a waterspread area of about 731.492 ha., while its catchment area is 851.488 ha.

Dahisar river originates from the Tulsi lake, flows through the forest of Magathana village and joins Manori creek near Dahisar village which ultimately merges with the Arabian sea near Manori village. Numerous small nallahs and tributaries join this river during its course through the park. The total catchment area of this river extends to over 2023.500 ha. The Rewat nallah originates from Avaghade hill to the SW of Yeur village and flows northwards, finally joining Bassein creek to the east of Versona bridge. The nallah is locally known as Laxmi river, while near its origin it is called as Vaghacha Khonda. The catchment area of this nallah extends to over 2225.850 ha.

Freshwater fishes present in the park . .

Order : Cypriniformes
Family : Cyprinidae
1. *Salmostoma clupeoides* (Bloch)
2. *Danio aequipinnatus* McClelland
3. *Rasbora daniconius* (Ham.)
4. *Puntius ticto* (Bam)
5. *Parapsilorhynchus tentaculatus* Annandale
6. *Garra mullya* (Sykes)

Order : Siluriformes
Family : Bagridae
7. *Aorichthys aor* (Ham.)
8. *Mystus menoda trachacanthus* (Val.)

Family : Heteropneustidae
9. *Heteropneustes fossilis* (Bloch)

Order : Atheriniformes
Family : Cyprinodontidae
10. *Aplocheilus lineatus* (Val.)

Order : Channiformes
Family : Channidae
11. *Channa punctatus* (Bloch)

Order : Perciformes
Family : Cichlidae
12. *Tilapia mossambica* Peters

Family : Anabantidae
13. *Anabas testudineus* (Bloch)

Family : Gobiidae
14. *Glossogobius giuris* (Ham.)

Prominent Marine fishes of Bassein creek

Order : Clupeiformes
Family : Clupeidae
1. *Hilsa toli* (Val.)

Family : Engraulidae
2. *Coila dussumieri* Val.
3. *C. neglecta* Whitehead

Order : Siluriformes
Family : Ariidae
4. *Arius caelatus* Val.
5. *A. sona* (Ham.)

Order : Myctophiformes
Family : HARPADONTIDAE
6. *Harpadon nehereus* (Ham.)
Order : Perciformes
Family : TERAPONIDAE
7. *Terapon jarbua* (Forsskal)
Family : SCIAENIDAE
8. *Johnius belangerii* (Cuvier)
9. *J. elongatus* Mohan
10. *J. macrohynus* (Mohan)
11. *Kathala axillaris* (Cuvier)
Family : MUGILIDAE
12. *Valamugil spiegleri* (Bleeker)
Family : GOBIIDAE
13. *Boleopthalmus boddarti* (Pallas)
14. *B. dussumerii* Val.

Parapsilorhynchus tentaculatus was found in small streams flowing past the Kanheri caves at an altitude of about 486 MSL. These streams finally meet Dahisar river. During the summer when the streams dry out, these fishes were seen in abundance in the numerous stone cisterns adjoining the caves. This is the first record of the fish from the region. It had previously been recorded from Khandala (Annandale 1919) and also near Pachmarhi along the Satpura hill range (Hora and Nair 1941).

As Dahisar river and Rewat nallah have a very short length, the indigenous fish fauna does not include large forms; rather small fishes like *Aplocheilus, Puntius, Danio, Rasbora* and *Garra* are found in plenty.

We thank the Director, Zoological Survey of India, Calcutta for sanctioning the survey of SGNP.

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24. NEW RECORDS OF APHIDS (HOMOPTERA: APHIDIDAE) FROM GARHWAL RANGE OF WESTERN HIMALAYA, INDIA

During recent surveys of Garhwal, an additional 28 aphid species to the already known 186 species are recorded in this paper. Thus, at present the total number of species from the area stands at 214. The aphid species along with their collection data are listed below. Out of these, only 11 species marked (*) are reported here as new to the state of Uttar Pradesh. All the aphid materials are presently deposited in the collection of Biosystematics Research Unit, Department of Zoology, University of Kalyani, Kalyani, West Bengal.

Abbreviations used: Aptera(e) denotes apterous viviparous female(s) and alata(e) denotes alate viviparous female(s) if not mentioned otherwise.

Subfamily APHIDINAE
Tribe APHIDINI

*__Hyalopterus pruni__ (Geoffroy)

Material examined: 6 apterae and 11 alatae, ex *Prunus* sp., Joshimath (*c.* 1950 m), 13.x.1982, coll. S. Chakrabarti.

*__Melanaphis arundinariae__ (Takahashi)

Material examined: 27 apterae, 9 alatae and 3 nymphs, ex *Pyrus pashia*, Joshimath (*c.* 1950 m), 11.v.1984, coll. B. Das.

Tribe MACROSIPHINI

Amphorophora ampullata bengalensis Hille Ris Lambers and Basu

Material examined: 5 apterae and 1 nymph, ex an unidentified fern, Gourikund (*c.* 1981 m), 9.x.1979, coll. D. K. Bhattacharya.

*__Aspidophorodon harvensis__ Verma

Material examined: 46 apterae and 31 nymphs, ex *Salix* sp., Lambagarh (*c.* 2300 m), 28.x.1981, coll. S. Saha.

*__Capitophorus carduinus__ (Walker)

Material examined: 3 apterae, ex *Cnicus wallichi*, Sayanachatti (*c.* 1770 m), 16.x.1981, coll. S. Raha; 8 apterae, ex *Cnicus wallichi*, Govindghat (*c.* 1829 m), 8.x.1983, coll. D. Ghosh.

*__Capitophorus elaeagni__ (del Guercio)

Material examined: 3 apterae and 1 nymph, ex *Cnicus wallichi*, Sayanachatti (*c.* 1770 m), 16.x.1981, coll. S. Raha; 17 apterae and 12 nymphs, ex *Cnicus thomsoni*, Sayanachatti (*c.* 1770 m), 8.x.1982, coll. P. K. Medda.

*__Capitophorus himalayensis__ Ghosh, Ghosh and Raychaudhuri

Material examined: 4 apterae and 3 nymphs, ex *Hippophae* sp., Govindghat (*c.* 1829 m), 10.vi.1978, coll. S. Chakrabarti.

Capitophorus hippophaes javanicus Hille Ris Lambers

Material examined: 3 apterae and 2 nymphs, ex *Polygonum* sp., Joshimath (*c.* 1950 m), 8.vi.1978, coll. D. K. Bhattacharya.

Chaetosiphon (Pentatrichopus) heterotrichus Chakrabarti, Ghosh and Raychaudhuri

Material examined: 3 apterae, 1 alata and 13 nymphs, ex *Labium* sp., Ghangaria (*c.* 3770 m), 25.x.1981, coll. A. K. Mandal; 5 apterae and 1 nymph, ex *Salvia glutinosa*, Govindghat (*c.* 1829 m), 15.ix.1982, coll. P. K. Medda.

Hayhurstia atriplicis (Linnaeus)

Material examined: 12 apterae, 4 alatae and 11 nymphs, ex *Chenopodium album*, Osla (*c.* 2559 m), 25.vi.1983, coll. B. Das.

Hyalomyzus (Neohyalomyzus) raoi Hille Ris Lambers

Material examined: 1 aptera, 1 alata and 11 nymphs, ex *Rubus mollucata*, Sitapur (*c.* 1825 m), 6.xi.1981, coll. A. K. Mandal.

Lipaphis erysimi (Kaltenbach)

Material examined: 14 apterae and 37 nymphs, ex *Brassica* sp., Joshimath (*c.* 1950 m), 20.iv.1985, coll. N. Debnath.

*__Macromyzus (Anthracosiphoniella) maculatum__ (Basu)

Material examined: 3 apterae, 1 alata and 3 nymphs, ex an unidentified fern, Kedarnath (*c.* 3584 m), 3.vi.1978, coll. S. Chakrabarti.

Micromyzodium dasi Verma

Material examined: 19 apterae, 2 alatae and 19 nymphs, ex *Adiantum caudatum*, Dehradun (*c.* 640 m), 25.x.1977; 12 apterae, 1 alate male and 9 nymphs, ex *Cheilanthus* sp., Dehradun (*c.* 640 m), 9.xi.1977, coll. S. P. Maity.

Myzus indicus Basu and Raychaudhuri

Material examined: 1 aptera, ex *Anelima* sp., Mussorie (*c.* 2005 m), 17.x.1976, coll. S. P. Maity.

Nasonovia (Kakimia) jammuensis Verma

Material examined: 3 apterae and 2 nymphs, ex *Rosa uncerinaefolia*, Gangotri (*c.* 3000 m), 7.vi.1980, coll. D. K. Bhattacharya.

Nasonovia (Kakimia) rostrata David and Hameed

Material examined: 1 aptera and 4 alatae, ex *Strobilanthes* sp., Govindghat (*c.* 1829 m), 23.x.1981, coll. S. Chakrabarti.

Vesiculaphis pieridis Basu

Material examined: 3 apterae and 4 nymphs, ex *Pieris ovalifolia*, Gangnani (*c.* 1300 m), 6.vi.1980, coll. S. Chakrabarti.

Tribe PTEROCOMMATINI

Pterocomma populifoliae (Fitch)

Material examined: 3 alatae, ex *Populus ciliata*, Ghangaria (*c.* 3770 m), 25.x.1981, coll. A. K. Mandal; 2 apterae and 1 nymph, ex *Populus ciliata*, Joshimath (*c.* 1950 m), 15.ix.1982, coll. S. Chakrabarti.

Subfamily CHAITOPHORINAE

Chaitophorus kapuri Hille Ris Lambers

Material examined: 85 apterae and 37 nymphs, ex *Populus ciliata*, Sayanachatti (*c.* 1770 m), 20.x.1981, coll. S. Raha.

Chaitophorus manaliensis Chakrabarti

Material examined: 3 apterae and 6 nymphs, ex *Salix* sp., Rambara (*c.* 2743 m), 27.v.1980, coll. S. Chakrabarti.

***Chaitophorus pakistanicus** Hille Ris Lambers

Material examined: 68 apterae, 1 alata and 18 nymphs, ex *Salix babylonica*, Dehradun (*c.* 640 m), 29.v.1978, coll. S. Chakrabarti.

Periphyllus californiensis (Shinji)

Material examined: 34 apterae, 2 alatae and 25 nymphs, ex *Acer oblongum*, Mussoorie (*c.* 2005 m), 31.x.1977, coll. S. Maity.

***Sipha (Rungsia) maydis** Passerini

Material examined: 28 apterae, 1 alata and 7 nymphs, ex *Digitaria* sp., *Eleusine coracona* and *Sorghum* sp., Govindghat (*c.* 1829 m), 23.x.1981, coll. S. Saha.

Subfamily HORMAPHIDINAE

***Doraphis populi** (Maskell)

Material examined: 7 alatae and 6 nymphs, ex *Populus ciliata*, Joshimath (*c.* 1950 m), 27.v.1984, coll. S. Saha.

***Tuberaphis loranthi** (van der Goot)

Material examined: 15 apterae, 5 alatae and 8 nymphs, ex *Loranthus cordifolius*, Trijuginarayan (*c.* 1982 m), 23.v.1980, coll. D. K. Bhattacharya.

Subfamily LACHNINAE

Pyrolachnus imbricatus David, Narayanan and Rajasingh

Material examined: 1 aptera, 1 alata and 17 nymphs, ex *Prunus cornutus*, Bhuinder (*c.* 2439 m), 5.vi.1981, coll. S. Saha; 3 apterae and 57 nymphs, ex *Prunus* sp., Pulnagaon (*c.* 1920 m), 15.ix.1982, coll. D. Ghosh.

Subfamily PEMPHIGINAE

Baizongia pistaciae (Linnaeus)

Material examined: 3 apterae and 1 nymph, ex *Pistacia integerrima*, Helong (*c.* 1524 m), 12.v.1984; 8 apterae and 9 nymphs, ex *Pistacia integerrima*, Joshimath (*c.* 1950 m), 6.vi.1984, coll. K. Dey.

ACKNOWLEDGEMENTS

Grateful acknowledgements are due to the Department of Science and Technology, New Delhi for financing the work and the Head, Department of Zoology, University of Kalyani for providing the laboratory facilities.

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25. A BUTTERFLY PHENOMENON

Butterflies have been a source of fascination for me ever since childhood, but the simple thrill of photographing them is a recent discovery. More than the satisfaction of securing a good close-up of a beautiful butterfly, what lingers in the mind is the pleasure of peeping into the wonderful world of those jewelled angels through the close-up lens.

On 10.v.1984, I was with a group of friends near the Banatheertham waterfalls, inside the Mundanthurai Tiger Sanctuary of Tamil Nadu, when my attention was suddenly caught by a group of seven or eight bluish butterflies trying to alight near a tiny pool in a rocky depression. For about three or four minutes, the butterflies fluttered about, apparently trying to land near the water.

Finally, three or four of them landed by the water's edge. When I was close enough, I cautiously, lowered my camera and slowly started clicking. Only after the first two or three shots, did I become aware of what I was seeing through my camera lens — something I had never seen or read about before. The butterfly was spurting tiny drops of liquid through its anus. It was doing this roughly at the rate of one spurt every five seconds. Each drop was spurted with such force that it fell four or five cm away from the insect's vent. The other butterflies were also doing the same. It was almost as if they were sucking water through their proboscis and ejecting it through their rear. Were they doing it to bring down the body temperature? If not, what could be the real reason behind the phenomenon?

Later on, I identified the butterflies as Blue Bottles (*Graphium sarpedon*). On another occasion I saw the same phenomenon in another butterfly, a 'Common Banded Peacock'. It also happened near a stream bed. But in this case there was only a solitary butterfly and it was resting on damp ground with wings spread out. There was no puddle of water anywhere near it. The rate of squirting was erratic but I was able to see the butterfly doing it four or five times before it flew away.

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26. *PARAPOYNX DIMINUTALIS* SNELLEN (PYRALIDAE: LEPIDOPTERA) AS A SERIOUS PEST OF *NYMPHOIDES CRISTATUM* IN KEOLADEO NATIONAL PARK, BHARATPUR, RAJASTHAN

One of the notable changes after the ban of buffalo grazing in Keoladeo National Park, Bharatpur, is the shrinking of open water habitat as a result of the invasion by *Paspalum distichum,* a perennial, amphibious grass. The reduction of open water area in turn limits the growth of floating vegetation, especially members of the genera *Nymphoides* and *Nymphaea.* In order to prevent the excessive growth of *Paspalum distichum,* the park authorities bulldozed certain areas in 1985. A tremendous growth of *Nymphoides cristatum* and *Nymphoides indicum* along with *Nymphaea nouchali* and *Nymphaea stellata* was noticed in the opened up areas.

During August, 1985, the leaves of *Nymphoides cristatum* were infested and fed on by the larval forms of *Parapoynx diminutalis.* At first the attack was mild but by April-May, 1986, almost all the leaves of *Nymphoides cristatum* were destroyed by the larvae. The early larval stages were found inside the leaf epidermis, but later stages came out of the leaves and stayed inside leaf folds, which were made by partially cutting and folding the leaf margin towards their ventral surface. The larvae frequently came out of the leaf folds to feed on the rest of the leaves. Mainly because of the larvae, the growth of *Nymphoides cristatum* in the park was considerably reduced by June-July, 1986. The life-cycle and population density of *Parapoynx diminutalis* are being studied in detail.

ACKNOWLEDGEMENTS

We are grateful to Dr. V. S. Vijayan, for his valuable suggestions and encouragement. We are also thankful to Dr. John B. Heppner, Curator of Lepidoptera, Florida State Museum for help in the identification of the insect, and to Mr. David A. Ferguson of the U. S. Fish and Wildlife Service, Washington for his help in getting the insect identified.

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27. LIFE TABLE STUDIES ON THE SPOTTED BOLLWORM *EARIAS VITTELLA* (FABRICIUS) (LEPIDOPTERA: NOCTUIDAE) IN COTTON ECOSYSTEM

INTRODUCTION

Life table is a systematic presentation of survival and mortality in a population (Harcourt 1969). It records the population or estimate of a species at sequential stages of the life cycle in its natural environment. In the present study on the population dynamics of the spotted bollworm *Earias vittella* (Fabricius) which is one of the serious pests of an economically important crop, viz. cotton, life tables were constructed with the observations recorded under field conditions.

Material and Methods

Life table studies were conducted in three different crop growth stages, viz. 60-80 DAS, 80-100 DAS, 100-120 DAS. MCU 5 cotton was sown on September 1, 1984, in an area of 567 sq. m. and this area was divided into 63 plots, each of 9 sq. m. Twenty one plots were allocated for the studies in every crop growth stage. These plots formed three replicates for seven samples which were distributed randomly, and 0.5 m space was maintained between plots to minimize the chances of migration of population of *E. vittella.*

E. vittella was reared in the laboratory at 28°±2°C and 85±5% R. H. using the growth chamber which was the prevailing atmospheric temperature and humidity during the study time. Female moths were made to lay eggs on muslin cloth provided as site for oviposition. The muslin, containing eggs, was clipped into small pieces so as to have 10 eggs on each piece of muslin. In each plot, ten plants were randomly selected and the piece of muslin containing 10 eggs was tied to the tip of each plant. This was done on 60 DAS, 80 DAS and 100 DAS for the studies in different crop growth stages respectively. Before placing the eggs, the plants were thoroughly examined for the eggs of *E. vittella* and these, if present were removed.

All the eggs from the first sample plots were collected two days after egg placement, brought to the laboratory and reared for emergence of parasites, if any. On the third day after egg placement, the eggs were counted in the second sample plots to know the extent of predation. Subsequently, on the fourth day after egg placement, observations were made on the non-fertile eggs and first instar larvae of *E. vittella* in third sample plots. All the fruiting bodies were cut open and examined for the number of live and dead I instar larvae. The dead larvae collected were kept in the laboratory to look for any parasite emergence. Observations were recorded in a similar way in the fourth, fifth and sixth sample plots for II, III and IV instar larvae respectively. Observations on the seventh sample plots were made for the number of cocoons, as pupation generally took place on the plant parts. The cocoons collected were reared in the laboratory for the emergence of adults and the sex ratio was established. The emergence of parasites from the cocoons, if any, were also recorded. The column headings used in the life table were those proposed by Morris and Miller (1954) and Harcourt (1969).

Results

a) *Life table on cotton* 60-80 DAS (Table 1)

During egg stage, there was a total mortality of 27.3%, of which 11.1% was due to non-fertility and 16.2% was due to predation by *Menochilus sexmaculatus.* The maximum mortality (64.1%) during the larval stages was seen in the I instar stage, which was due to inability to establish the population. The mortality at the II instar stage was 13.8% which was due to unknown reasons. There was 25.3% mortality due to unknown reasons in the III instar stage. During the IV instar stage, 40.5% mortality was observed, which was also due to unknown reasons. Parasitisation to the extent of 0.8% due to *Tetrastichus* sp. was noticed during the pupal stage. This parasite has been found to be new to science and is being described elsewhere. There was also 13.0% parasitisation in the pupal stage by *Agathes* sp. The trend index was 1.94 and the generation survival was 0.032.

b) *Life table on cotton* 80-100 DAS (Table 2).

There was 12.3% predation by *M. sexmaculatus* and 26.8% non-fertility during the egg stage. Very high mortality of 72.1% was recorded in the I instar stage, which was due to inability to establish the population. During II, III, IV instars and pupal stage, the mortality was due to unknown reasons and it was 22.9%, 22.9%, 18.8% and 13.4% respectively. The trend index was 3.19 and generation survival was 0.12.

c) *Life table on cotton* 100-120 DAS (Table 3).

There was 16.5% predation by *M. sexmaculatus* and 37.3% non-fertility during egg stage. The I instar suffered 72.1% mortality due to the inability to establish the population. The mortality in II, III and IV instar larval stages were due to unknown reasons and were 13.2%, 21.4% and 12.5% respectively. The mortality during pupal stage was 74.1% which was due to unknown reasons and was high as in I instar stage. The trend index was 0.835 and generation survival was 0.043.

TABLE 1

LIFE TABLE OF *Earias vittella* ON COTTON 60-80 DAS SOWN IN SEPT. 1984

Age interval	No. alive at beginning of x	No. dying during x	Factors responsible for dx	dx as % of lx	Survival rate within x	log of lx	K value
(x)	(lx)	(dx)	(dxF)	(100qx)	(sx)	log lx	K
Eggs	1000	162	Predation	16.2			
		111	Non-fertility	11.1	0.727	3.000	0.138
I instar (N_1)	727	466	Inability to establish	64.1	0.359	2.862	0.445
II instar	261	36	Unknown reasons	13.8	0.862	2.417	0.065
III instar	225	57	Unknown reasons	25.3	0.747	2.352	0.127
IV instar	168	68	Unknown reasons	40.5	0.595	2.225	0.225
Pupae	100	34	Unknown reasons	34.0			
		8	Parasitisation due to *Tetrastichus* sp.	8.9			
		13	Parasitisation due to *Agathes* sp.	13.0	0.450	2.000	0.347
Adults (N_2)	45					1.653	0.653
Females	10					1.000	
No. of eggs laid		1923		Generation survival		$\frac{N_3}{N_1} = 0.032$	
No. of I instar in the next generation (N_2)		1410		Trend index		$\frac{N_2}{N_1} = 1.94$	

TABLE 2

LIFE TABLE OF *Earias vittella* ON COTTON 80-100 DAS SOWN IN SEPT. 1984

Age interval	No. alive at beginning of x	No. dying during x	Factors responsible for dx	dx as % of lx	Survival rate within x	log of lx	K value
(x)	(lx)	(dx)	(dxF)	(100qx)	(sx)	log lx	K
Eggs	1000	123	Predation	12.3			
		268	Non-fertility	26.8	0.809	3.000	0.215
I instar (N_1)	609	439	Inability to establish	72.1	0.279	2.785	0.555
II instar	170	39	Unknown reasons	22.9	0.771	2.230	0.113
III instar	131	30	Unknown reasons	22.9	0.771	2.117	0.113
IV instar	101	19	Unknown reasons	18.8	0.812	2.004	0.09
Pupae	82	11	Unknown reasons	13.4	0.866	1.914	0.063
Adults (N_3)	71					1.851	0.404
Females	28					1.447	

No. of eggs laid 3156 Generation survival $\frac{N_3}{N_1} = 0.12$

No. of I instar in the next generation (N_2) 1941 Trend index $\frac{N_2}{N_1} = 3.19$

TABLE 3

LIFE TABLE OF *Earias vittella* ON COTTON 100-120 DAS SOWN IN SEPT. 1984

Age interval	No. alive at beginning of x	No. dying during x	Factors responsible for dx	dx as % of lx	Survival rate within x	log of lx	K value
(x)	(lx)	(dx)	(dxF)	(100qx)	(sx)	log lx	K
Eggs	1000	165	Predation	16.5			
		373	Non-fertility	37.3	0.462	3.000	0.335
I instar (N_1)	462	333	Inability to establish	72.1	0.279	2.665	0.554
II instar	129	17	Unknown reasons	13.2	0.868	2.111	0.062
III instar	112	24	Unknown reasons	21.4	0.786	2.049	0.105
IV instar	88	11	Unknown reasons	12.5	0.875	1.944	0.058
Pupae	77	57	Unknown reasons	74.1	0.260	1.886	0.585
Adults (N_3)	20					1.301	0.301
Females	10					1.000	

No. of eggs laid 642 Generation survival $\frac{N_3}{N_1} = 0.043$

No. of I instar in the next generation (N_2) 386 Trend index $\frac{N_2}{N_1} = 0.835$

DISCUSSION

The trend index was positive during 60-80 DAS and 80-100 DAS and negative during 100-120 DAS. There was approximately two-fold increase of population during 60-80 DAS and three-fold increase during 80-100 DAS. During these periods, the cotton flower and cotton bolls formed the larval food. The net reproductive rate in life table studies conducted in laboratory conditions with cotton flowers and bolls as larval food were 93.17 and 93.96 respectively (Ambegaonkar and Bilapate 1982). Such high reproductive rate of the moth, in spite of the low generation survival, can be attributed to the trend index which was positive during 60-100 DAS. During 100-120 DAS the trend index was negative, indicating decline in the population.

The prevalence of the predation of *E. vittella* eggs by *M. sexmaculatus* was observed in all the stages, and pupal parasitisation by *Agathes* sp. and *Tetrastichus* sp. was observed only during 60-80 DAS. The predation of *E. vittella* eggs by *M. sexmaculatus* has already been reported by Das and Basu (1977), and the occurrence of *Agathes* sp. on *E. vittella* has been reported by Cherian and Kylasam (1941).

Tetrastichus sp. as a pupal parasite of *E. vittella* recorded during this study formed the first report.

CONCLUSION

Owing to the meagre occurrence of natural enemies in the ecosystem and also to the positive trend index during 60-100 DAS, it is evident that the mortality factors existing in nature during these periods were not effective in checking population growth of *E. vittella*. The need for taking up proper plant protection measures during 60-100 DAS cotton is revealed.

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28. LOSS ESTIMATION IN CABBAGE DUE TO LEAF WEBBER *CROCIDOLOMIA BINOTALIS* (LEPIDOPTERA: PYRALIDAE)

(*With three text-figures*)

INTRODUCTION

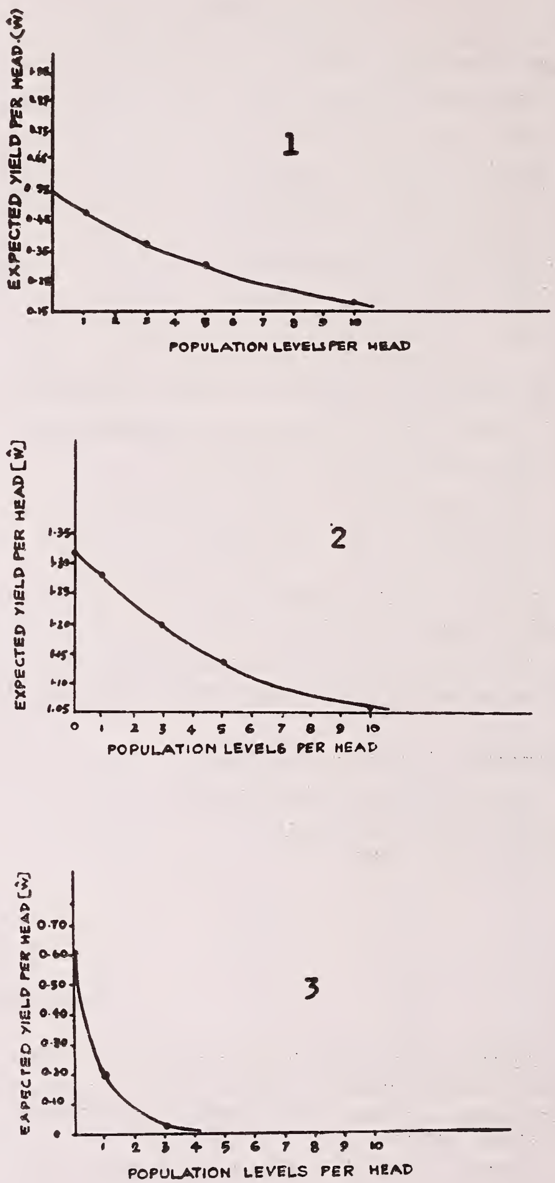
The loss caused by insects is generally a function of insect population density and the losses caused by pests vary in time and space (Strickland and Bardner 1967). Pradhan (1964) emphasised the need for assessment of losses caused by insect pests of crops and estimation of insect populations.

Crocidolomia binotalis Zeller is considered to be a major pest of cabbage in South India. However, there is no record of the actual loss caused to the crop by this pest. Hence, in the present investigation an attempt was made to assess the economic loss caused by *C. binotalis* as a pest of cabbage.

MATERIAL AND METHODS

The studies were carried out at the Indian Institute of Horticultural Research Farm at Hesserghatta, Bangalore.

To assess the economic damage, three crop ages were taken; 15 days old, 30 days old and 45 days old. The variety was Golden Acre. Twelve plants for each replication were covered with iron mesh, wooden cages, 1.8 × 1.2 × 1.8 m in the field. All replications were randomised in 1000 square metres area of cabbage. There were five treatments, viz. artificial infestation of plants with 0, 1, 3, 5, 10 larvae, with three replications of each. Damage occurred for a fortnight, which is the larval period. About 20% of the larvae migrated, but the total number of larvae was maintained by re-infestation with larvae of the same age. The control was kept infestation-free with quinalphos (250 g a.i/ha) spray every week. A relationship between yield and different levels of pest population maintained has been fitted to exponential decay curve as $W = ae^{-bx}$ where



Exponential equation curve of cabbage yield against different population levels.
Fig. 1. 15 days old crop; Fig. 2. 30 days old crop; Fig. 3. 45 days old crop.

W is the expected yield and X is the number of larvae per plant.

RESULTS AND DISCUSSION

Mean yields corresponding to different levels of larval population at different stages of the crop growth are shown in table 1. At all the growth stages of the crop, significant reduction in yield was observed over control with increase in the different population levels maintained.

The data was adequately fitted to exponential curves for all the three crop stages and is useful in explaining the rate of decrease of yield with unit increase of larval population.

i) *15-days old crop*:

It has been observed that with unit increase of larval population, there is a significant reduction in yield over control. This revealed that even a single larvae per plant could cause sufficient economic loss to the crop. With further increase in population, decrease in yield was slow because of increased availability of food. The exponential growth curve $W = 0.5333\, e^{-0.1028x}$ adequately explained the data at different levels of population (fig. 1).

ii) *30-days old crop*:

Percentage loss in yield (28.09) with unit increase in larval population over control was less in this stage as compared to 15 days old crop and injurious at three larvae per plant. None of the maintained levels of population could cause complete loss of yield. The exponential growth curve $W = 0.32\, e^{-0.1616x}$ showed good fit to yield-pest density relationship (fig. 2).

iii) *45-days old crop*:

37.19% loss in yield with unit increase in larval population over control has been observed in this age of the crop which is higher than 30-days old crop. With further increase of population, total loss in yield was recorded. The data showed the best fit to exponential curve $W = 0.6119\, e^{-1.1493x}$ (fig. 3).

The comparison of yield loss at all the three growth stages of crop revealed that a single leaf webber larva is sufficient to cause economic damage to cabbage crop. It was also observed that the yield loss was faster at 15 days growth of crop. This indicated that if the

TABLE 1

CABBAGE YIELD AFTER ARTIFICIAL INFESTATION DURING THREE GROWTH STAGES

No. of larve maintained	Mean yield per plant (kg)					
	15 days		30 days		45 days	
0	0.7882	—	0.4576	—	0.4578	—
1	0.3867	(50.88)	0.3292	(28.09)	0.2875	(37.19)
3	0.3343	(57.53)	0.1360	(70.39)	0.1670	(96.35)
5	0.2713	(69.54)	0.1000	(76.69)	—	—
10	0.2219	(71.80)	0.0881	(80.78)	—	—
S.E.M.	0.083		0.077		—	—
CD (5%)	0.1914		0.1776		—	

Figures in parentheses show % loss over control.

*Statistical analysis for the third set (viz. 45 days) could not be carried out since most values were zero at higher level of infestation.

crop is attacked by the leaf webber at the early stages of crop growth, then proper control measures should be adopted to avoid economic damage to the crop.

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29. THE FOOD OF *BENGALIA LATERALIS* MACQUART, 1842 (DIPTERA: CALLIPHORIDAE) IN SRI LANKA

On 21 November, 1986 a rather robust brown fly was observed flying inside my house in Kotte, a suburb of Colombo, around 18.30 hrs. A few winged termites (*Odontotermes* sp.) had also been attracted indoors by the lights and were fluttering about. Suddenly, I noticed that the fly had captured one of these termites (the exact moment of capture was not seen) and was flying with the termite held in its legs. It soon settled on a metal curtain rail and, holding its prey down on its back with its fore legs, proceeded to feed on the soft underside of the termite's abdomen. The fly fed on the termite for some 5-10 minutes, and throughout this period the termite moved its legs ineffectually in an attempt to free itself. It could not move its wings which were held down by the fly's hind legs. After feeding on the termite the fly let it drop to the ground and settled, after flying around, elsewhere, from where it was captured for identification.

On examination, the fly proved to be a species of *Bengalia* and was identified with the aid of Senior White *et al.* (1940) as *Bengalia lateralis* Macquart, 1842 from the structure of the cleared genitalia; the superior claspers agreed well with Fig. 43 (lower) of Senior White *et al.* (loc. cit.). Previous to this, two female *Bengalia* specimens were collected, also from indoors, which appear to belong to this species, and from other observations it would appear that this is a common species. A correspondent of the writer, T. A. Wijesiri of Opatha, Kotugoda (Gampaha District), has observed a *Bengalia* fly, presumably the same species, which is commonly attracted to opened-up nests of the ant *Oecophylla smaragdina* (Fabricius) to feed on the ant pupae.

These observations are worth recording as little is known about the habits of many common calliphorids which are not of economic importance. The habit of taking ant pupae has been observed earlier in several *Bengalia* species but the use of termites as food by these flies has not been reported often.

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30. RECORD OF PARASITOIDS OF *ASPHONDYLIA RIVEAE* MANI (CECIDOMYIIDAE: DIPTERA)

Asphondylia riveae Mani is known to cause characteristic leaf fold galls on *Rivea hypocrateriformis* throughout South India.

During December, 1985 heavy infestation of the gall midge on *R. hypocrateriformis* was noticed in Padappai, Chingleput District, Tamil Nadu. It was observed that the larvae of *A. riveae* have been parasitised by a number of hymenopteran parasites which are listed below.

1. *Eurytoma* sp. prox. *dentata* Mayr (Eurytomidae)
2. *Tetrastichus* sp. (Eulophidae)
3. *Sigmophora* sp. (Eulophidae)
4. *Bracon* sp. (Braconidae)

The identity of the first two parasitoids were established through the kind courtesy of Dr. Z. Boucek and the other two by Dr. A. K. Walker of the C.A.B. International Institute of Entomology, British Museum (Natural History), London. This report appears to be the first record of parasitoids of *A. riveae.*

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31. NEW RECORD OF *CRYPTOPODIA ANGULATA* MILNE-EDWARDS & LUCAS (PARTHENOPIDAE: DECAPODA: CRUSTACEA) FROM MALAYSIAN WATERS

The type locality of *Cryptopodia angulata* Milne-Edwards & Lucas, 1841 is not known. According to Alcock(1895), the species occurs along both the coasts of the Indian subcontinent, while the variety *cippifer* is known only from Karachi. On the voyage to Indian Seas by 'Investigator', Alcock (1902) encountered an abundance of *C. angulata* off the Orissa coast. It was later reported in fairly large numbers from the mouth of the Hughli River in West Bengal (Chopra 1935). The collections of the Indian Museum contained a single specimen of this species from off Honawar along the west coast of India, but Chopra (1935) doubted the specimen's true identification due to the profuse granulations on its carapace and cheliped and the more sharply toothed pattern of the borders of the carapace. Flipse (1930) gave identification keys for the species but made no mention of its distribution, and Chopra (1935) probably made a mistake in quoting this paper regarding the distribution of the species. At a later period, Chhapgar (1957) reported the species from Bombay area with a drawings of the species and its gonopod. We have collected a number of specimens of *C. angulata* from the Chittagong coast of Bangladesh between 1981 and 1983 (manuscript under preparation).

The above mentioned works indicate that *C. angulata* is a relatively uncommon species with a distribution limited to the northern part of the Indian Ocean around 20°N latitude.

It is for the first time that a specimen of *C. angulata* has been collected from the waters off Penang island of Malaysia as south as 5°N latitude. This record extends the eastern and southern distributional limits of the species. The specimen was collected from fishing hauls at Batu Ferringi of Penang in 1983. It agrees with the type description by Milne-Edwards and Lucas (1841) except that the globular carpus of the cheliped is granulated and the palp of the third maxilliped has a row of strong setae along the inner margin of the propodus and dactylus. The present specimen, a female, is 25 mm long and 50 mm broad. Its abdominal segments conform with Chopra's (1935) observation of being keeled and sharply tuberculate. The Bangladesh specimen is similar to the present one but does not have granulation on the carpus of the cheliped.

ACKNOWLEDGEMENTS

We are indebted to Mr. K. Sagathevan of the University of Malaya for providing the specimen and to Mr. Peter K. L. Ng of the Singapore National University for assistance in obtaining literature.

DEPARTMENT OF ZOOLOGY,
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KUALA LUMPUR, MALAYSIA,
April 11, 1987.

QAMAR BANU
K. M. NURUL HUDA

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32. NEW RECORDS OF PRAWNS, SHRIMPS AND AMPHIPODS FROM LAKE KOLLERU WITH NOTES ON THEIR DISTRIBUTION

Lake Kollru (250 sq. km.) is the largest among the essentially freshwater lakes of India although it is connected to the Bay of Bengal. It is situated in Andhra Pradesh between 16° 31′-16° 47′ N and 81° 4′-81° 22′ E. A preliminary survey of the flora, fauna and fisheries of the lake, made by Chacko *et al.* (1952) listed five species of prawns; Panikker & Menon (1955) referred to seven species of prawns. There was no previous record of the amphipods of the lake.

Altogether 14 species of prawns and 11 species of amphipods were recorded during the years 1975-1978 and are listed below.

PRAWNS

Family: PALAEMONIDAE
1. *Macrobrachium rosenbergii schenkeli* Johnson
2. *M. malcolmsonii malcolmsonii* (Milne-Edwards)
3. *M. idella* (Hilgendorf)
4. *M. rude* (Heller)
5. *M. scabriculum* (Heller)
6. *M. lamarrei lamarrei* (Milne-Edwards)

Family: ATYIDAE
7. *Caridina pseudogracilirostris* Thomas. Pillai & Pillai
8. *C. rajadhari* Bouvier
9. *C. propinqua* de Man
10. *C. weberi sumatrensis* de Man

Family: PENAEIDAE
11. *Penaeus* (*Penaeus*) *monodon* (Fabricius)
12. *Penaeus* (*Fenneropenaeus*) *indicus* Milne-Edwards
13. *Metapenaeus dobsoni* (Miers)
14. *M. monoceros* (Fabricius)

AMPHIPODS

Family: AMPHILOCHIDAE
15. *Amphilochus brunneus* Della Valle

Family: COROPHIIDAE
16. *Grandidierella bonnieroides* Stephenson
17. *G. gravipes* Chilton
18. *Corophium madrasensis* Nayar
19. *Podoceropsis insignis* Chilton

Family: EUSIRIDAE
20. *Paracalliope indica* Barnard

Family: GAMMARIDAE
21. *Elasmopus pectenicrus* (Bate)
22. *Eriopisella sychellensis* (Chevreux)
23. *Quadrivisio bengalensis* Stebbing

Family: TALITRIDAE
24. *Orchestia platensis* Kroyer
25. *Talorchestia martensii* (Weber)

Seven (3, 6, 7 to 10, 13) of the 14 prawns and shrimps listed above are recorded for the first time from the lake. The majority of the forms are freshwater in origin. Marine component of the fauna is poor (11 to 14). The bulk of commercial prawn catch is composed of four species (1, 2, 13, 14). The distribution of forms 1 to 5 is predominantly coastal though there are some localities well removed from the sea along the course of large rivers. Atyid species (7 to 10) are generally distributed among the roots of floating vegetation and slow-moving water.

All the amphipods (15 to 25) are being recorded for the first time from the lake. *Podoceropsis insignis* was earlier recorded only from Tale Sap in Thailand; it is recorded for the first time from outside that area. The present record of amphipods helps to bridge the distributional gap between the southern and north-eastern parts of India.

I thank the Andhra University for award of a fellowship.

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August 22, 1987.

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33. A FIRST REPORT OF AN ARACHNID ORDER UROPYGIDA (WHIP SCORPION) FROM MAHARASHTRA

(*With a text-figure*)

The Uropygids, commonly known as whip-scorpions, are natives of Oriental and Neotropical evergreen forests. At once recognisable from Scorpions by the presence of a deep constriction between the cephalothorax and abdomen, by the absence of pectines and a long thin whiplike tail instead of a broadly segmented metasoma bearing a poison gland at the tip. Whipscorpions are animals of moderate size, and range between 20-50 mm in total body length. They generally live under bark and forest litter and thus go unnoticed. There are about 44 species under 15 genera from the Oriental region of which only 6 species of 4 genera have so far been described from India, namely *Thelyphonus sepiaris* Butler, 1873 (Madras, Tamil Nadu), *T. cristatus* Pocock, 1900 (West Bengal), *Uroproctus assamensis* Stolicza, 1869 (Khasi Hills, Meghalaya, *Labochirus tauricornis* Pocock, 1899 (Mangalore, Karnataka) and *Hypoctonus oatesii* Pocock, 1900 (Assam) (Fig. 1A).

It is apparent from the distributional records that the Indian species of whipscorpions have been reported only from southern, eastern and north-eastern parts of the country and hitherto there was no record available of this group from western India and especially from Maharashtra. Thus this note intends to place on record the existence of this order in the state of Maharashtra and to extend its distribution in western India.

A single specimen (male) was recovered from forest litter from Chandgad (lat. 15° 55′ N, long. 74° 10′ E; 850 MSL) of Kolhapur District, Maharashtra during recent mopping survey programme, 1986. This specimen measures 27.50 mm in total body length and the tail or whip measures more than half the total length. The whip comprises of more than 40 uneven, sparsely haired annuli. A pair of omatidia is conspicuous on the last abdominal segment. This specimen belongs to the family Hypoctonidae and the genus *Labochirus* Pocock, but it does not fit into the key of known Indian species (Fig. 1 B).

FIG. 1

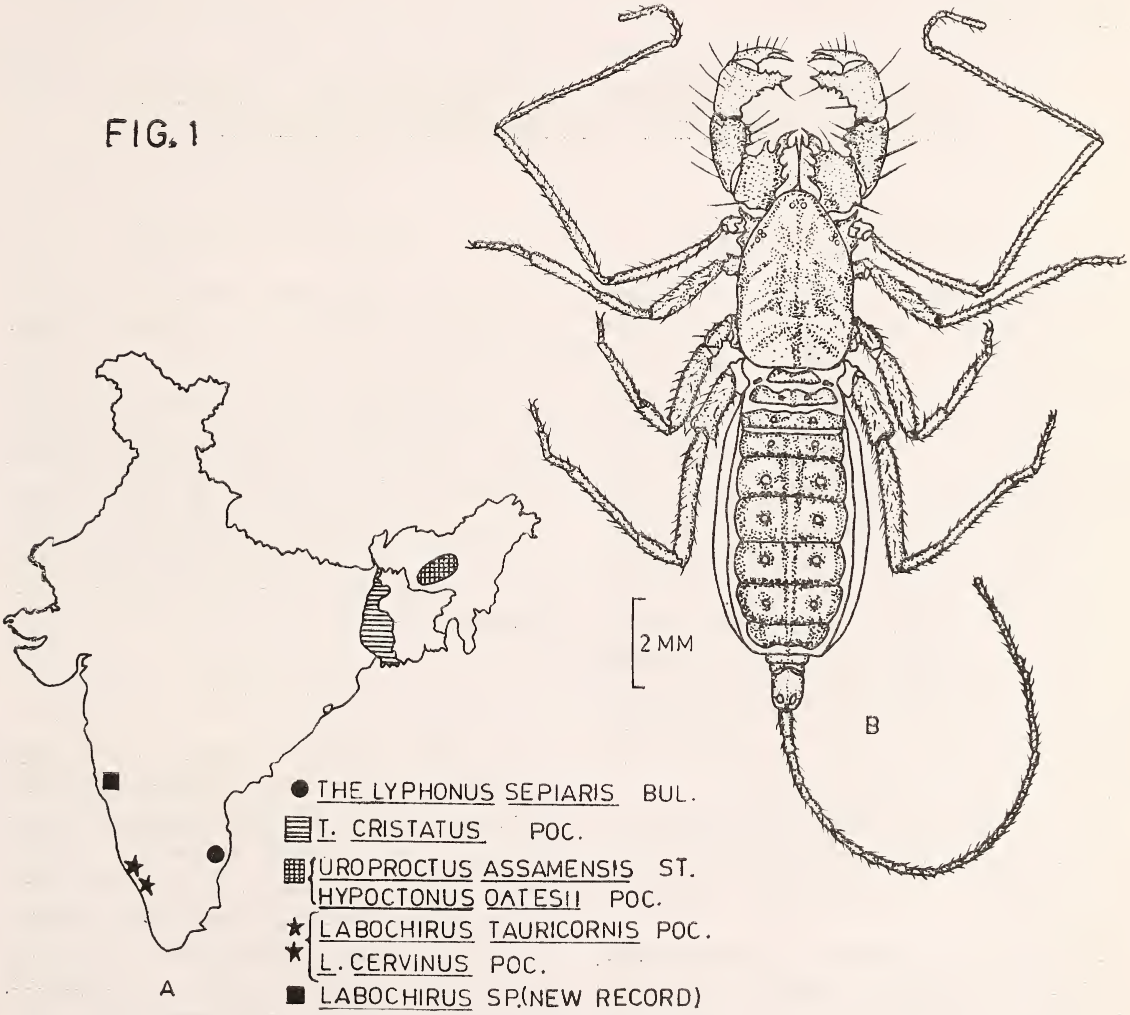
● THELYPHONUS SEPIARIS BUL.
▤ T. CRISTATUS POC.
▦ { UROPROCTUS ASSAMENSIS ST.
HYPOCTONUS OATESII POC.
★ { LABOCHIRUS TAURICORNIS POC.
★ L. CERVINUS POC.
■ LABOCHIRUS SP.(NEW RECORD)
A
2 MM
B

Fig. 1. A. Showing the distribution of Uropygid species in India.
B. Showing a specimen collected from Kolhapur District, Maharashtra, Western India.

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D. B. BASTAWADE

ZOOLOGICAL SURVEY OF INDIA,
WESTERN REGIONAL STATION,
PUNE - 411 016,
May 29, 1987.

34. AGGREGATING TENDENCY IN *MESOBUTHUS TAMULUS TAMULUS* (FABRICIUS) (SCORPIONIDA, BUTHIDAE)

INTRODUCTION

It is known that scorpions do not display social organisation. Fabre (1907), in his study of *Buthus occitanus,* noted that he did not find two of them under the same stone; whenever there were two, one was engaged in eating the other! Cloudsley-Thompson (1958) pointed out that no association of individuals was tolerated by any species. Vachon (1952) did not find any evidence of social instincts in European scorpions.

An account by McAlister (1966) on *Centruroides vittatus* Say (Scorpionida, Buthidae) about its aggregating tendency, formed a turning point in the study of scorpion behaviour. Polis and Lourenco (1986) studied the evolution of sociality among scorpions.

The present paper deals with an observations on *Mesobuthus tamulus tamulus* (Fabr.), the commonly occurring yellow scorpion in Maharashtra.

Under captive conditions, scorpions display an abnormal aggregating behaviour due to lack of shelter. Some Buthids live in colonies and all members of a colony live in the same burrow or hole (Tikader and Bastawade 1983).

MATERIAL AND METHODS

Seventeen females and 4 males of *M. t. tamulus* (Fabr.) collected near Bopkhel village, Dapodi, Pune were kept under observations in a wooden cage of size 45 cm × 30 cm × 30 cm with its three sides of wire mesh and top with a glass door. A layer of black soil was spread up to 2 cm. depth at the bottom. Pieces of coconut shell were kept in the cage as shelter. These shells were dislodged daily. Insects were given as food and water was replaced twice a week in the cage.

OBSERVATIONS

At night, scorpions roamed in the cage, with their pedipalps held up, fingers open, and metasoma raised vertically. However in the morning, they clustered below the coconut shells, inactive and lying one above the other. The pedipalps were closed near the chelicerae and the scorpions resisted removal from this association. Though the shelter was displaced, daily, the scorpions were located below the shell, the next day. However, in the field, ***M. t. tamulus*** (Fabr.) do not aggregate, one or two scorpions only being collected from below a stone.

DISCUSSION

Cole (1946) discussed the factors which cause contagious distributions; sexual attraction, social instinct and favourable environmental conditions. McAlister (1966) stated that the aggregation of *C. vittatus* Say is a reflection of social instinct.

In spite of cannibalistic habit and irrespective of sex, *M. t. tamulus* were found aggregated only during the day. This aggregation is obviously the result of avoidance reaction of *M. t. tamulus* to daylight and the scarcity of shelter. Similar activity patterns of scorpions have been recorded in a separate study related to feeding (Yadav and Kamble 1987).

ACKNOWLEDGEMENTS

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MAHARASHTRA,
August 21, 1987.

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35. A NEW RECORD OF *IXOIDES CORNUTUS* MACGILCHRIST, 1905 (DECAPODA: BRACHYURA) FROM INDIAN WATERS

(*With three text-figures*)

INTRODUCTION

The crab was collected from the daily fish catch of the mechanised boats brought to the offshore fishing harbour, Visakhapatnam. As it has not so far been recorded from Indian waters, a description is given. The species was reported earlier by Gordon (1930-1932) from China, Stephenson (1945) from Iran and Sakai (1965) from Sagami Bay.

DESCRIPTION

Measurements: 1 ♂ 28 mm long, 32 mm wide; 2 ♀♀ 29 mm long, 32 mm wide and 27 mm long, 31 mm wide (width excluding lateral spines which measure 13 mm and 14 mm respectively). Collected from offshore fishing harbour, Visakhapatnam.

Carapace light pink in formaline. Gastric region of carapace granular. Branchial region separated from gastric, cardiac, intestinal regions and also from hepatic region by grooves. Branchial region elevated as a lobe. Pterygostomian region bears a tubercle, visible from above. A deep notch on the antero-lateral margin at the hepatic region. Lateral spines long, cylindrical and gradually tapered. Posterior margin bears a blunt spine, on either side is a petaloid process. Front cut into two lobes by a deep groove, each lobe tooth-like.

First two pairs of pereiopods longer than the next two pairs. Distal end of the carpus has a tubercle. Both borders of dactylus plumed. Chelate leg long and slender. Inner border of arm granular and upper surface of the arm finely granular. Palm twice as long as the fingers. Proximal end broad and distal end of the palm slender (fig. 1).

Ischium of third maxilliped covered by large granules. Exognath also bears a row of large pearly granules. Male abdomen has five segments. The third segment longer and bears an elevation on either side at its base. Third, fourth and fifth segments longer than broad.

First pleopod of male long. Below the tip of the first pleopod, the outer border bears both long hairs and spinules. Inner border bears only long hairs (figs. 2 & 3).

Distribution: Japan, Sagami Bay, Hong Kong and Persian Gulf.

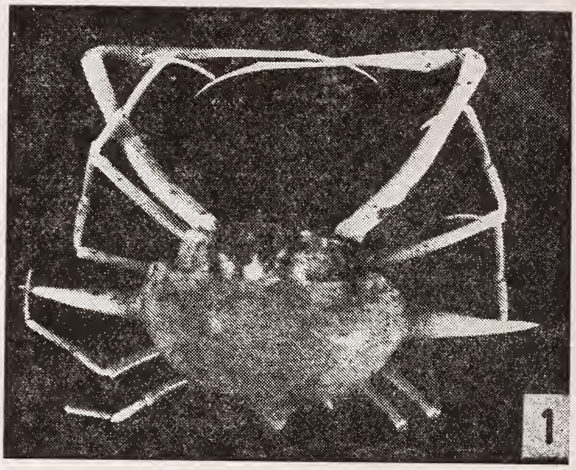

Fig. 1. *Ixoides cornutus* MacGilchrist.

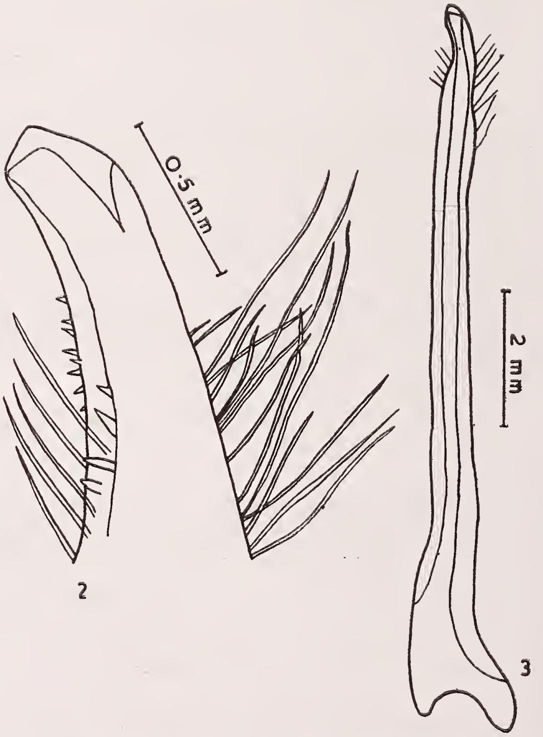

Fig. 2. Tip of the first pleopod of male enlarged; Fig. 3. First pleopod of male — entire.

REMARKS

During three years of extensive collection of Brachyura only a single male and two females were collected, which indicates the rarity of the species. The above description conforms to that of Sakai (1965).

ACKNOWLEDGEMENTS

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STEPHENSON, K. (1945): The brachyura of the Iranian Gulf. *Dan. Sci. Invest. Iran, 4*: 57-237.

36. A NEW VARIETY OF *SKIMMIA LAUREOLA* (DC.) SIEB. ET ZUCC. EX WALPERS (RUTACEAE) FROM MANIPUR, INDIA

(*With a text-figure*)

While revising the genus *Skimmia* Thunb. from India, we came across an interesting collection of *Skimmia laureola,* made by G. Watt from Manipur in 1882. The peculiarity of the specimen was recognised by Watt himself. He noted that it was "a peculiar variety with small leaves and racemes and three free styles" and as such ascribed it a varietal status with the epithet "*multiracemosa*". This finding, however, remained unpublished until now. We feel that it stands apart as a variety of *Skimmia laureola,* but the epithet '*multiracemosa*' (in herb.) as proposed by Watt is not appropriate as the inflorescence is basically a panicle with short peduncle bearing flowers in 2-3 nate clustures at the base and solitary towards the apex.

A detailed description of this new taxon with illustrations is given here.

Skimmia laureola (DC.) Sieb. et Zucc. ex Walpers var. **wattii** Narayanan et Nayar var. nov. (Fig. 1)

A varietate typica differt foliis elliptico-oblongis, chartaceis, apicibus brevissime acuminatis, acumine ad extremitatem obtuso, nervis secondariis inconspicuis, 5-9 paribus, prope marginem arcuatim junctis, inflorescentiis paniculatis, pedunculis brevibus, usque ad 2 cm longis, floribus densis, ad basin 2-3 in fasciculis, solitariis prope apicem, sepalis petalisque manifeste pellucido-punctatis.

Typus: *Watt* 6459 (Holo & Iso CAL), India, Manipur State, Sirohifurar, 2425 m, April 1882.

Scandent or erect densely branched shrubs;

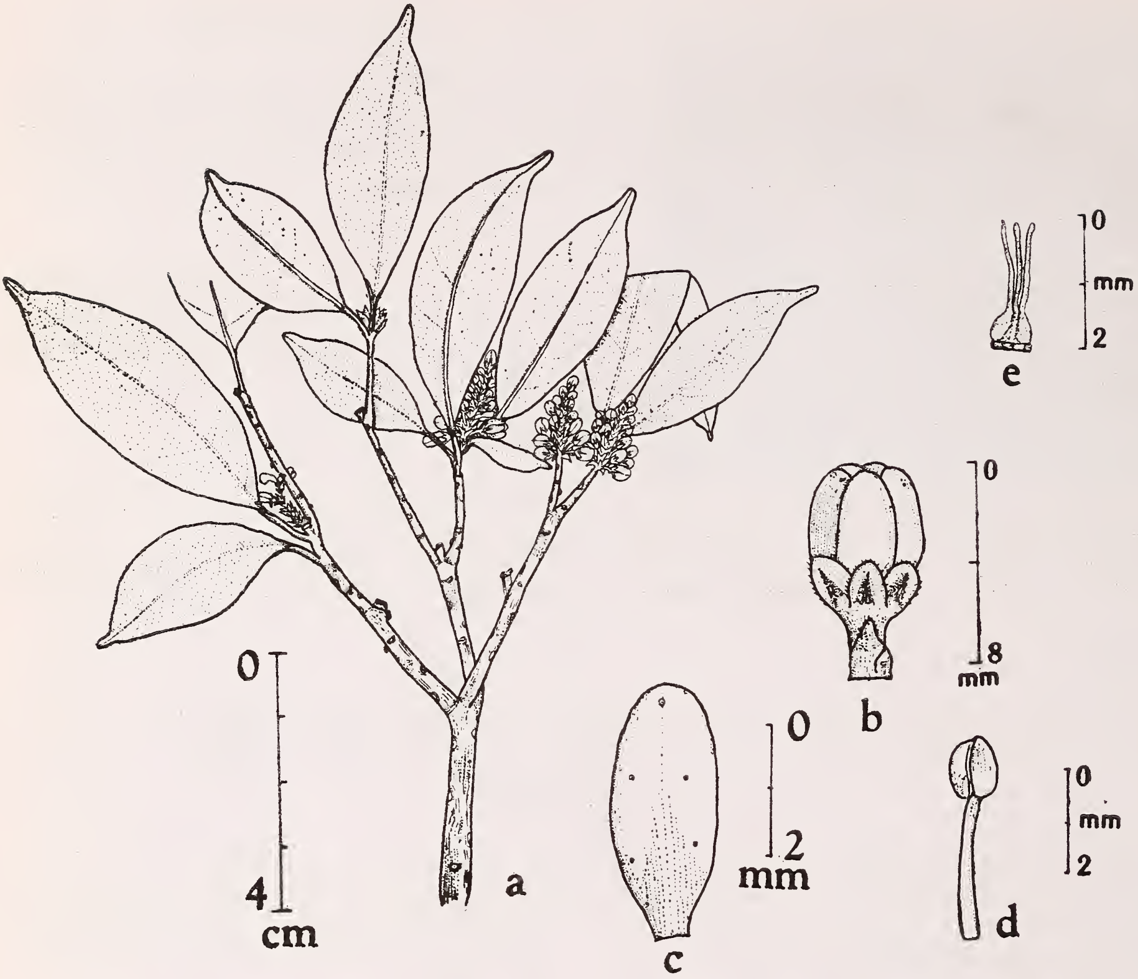

Fig. 1. *Skimmia laureola* (DC.) Sieb. et Zucc. ex Walpers var. *wattii* Narayanan et Nayar.
a. habit; b. Flower bud; c. petal; d. stamen; e. pistillodes.

branchlets rather woody, terete, glabrous; bark greyish, minutely fissured, lenticellate. Leaves simple, alternate, often crowded towards tips of branchlets forming a false verticellum, petiole 10-12 mm long, slender, winged, blades 3.0-5.5 (–6.5) cm long, 1.5-2.0 (–2.5) cm broad, elliptic-oblong, base attenuate, shortly acuminate at apex, acumen 4-6 mm long, blunt at tip, margin entire, chartaceous, above brown and below pale on drying, prominently pellucid-dotted, glabrous, midrib depressed above, prominent below, secondary nerves faint, 5-9 pairs, dividing near margin to form rather distinct intramarginal loop. Inflorescence paniculate, subterminal and axillary, peduncle sessile, short, 1.0-1.5 (–2.0) cm long, glabrascent; bracts 2-3 mm long, lanceolate, acute at tip, ciliolate; bracteoles 2, opposite to each other clasping the pedicels, *c.* 1 mm long, sub-orbicular, obtuse at tip, glandular, ciliolate; pedicels obsolete to 2 mm long, glabrascent. Flowers abortively unisexual, *c.* 5 mm long, 5-merous, sub-globose in buds. Male flowers: sepals 5, connate at below, imbricate, unequal in size, 1.2-2.0 mm long, sub-orbicular or narrowly oblong, obtuse to rounded at tip, glandular, ciliolate; petals 5, imbricate, 3-5-5.0 mm long, narrowly oblong, shortly stiped below, obtuse at tip, glandular, glabrous; stamens 5, opposite to sepals, arising from the base of disc, as long as the petals, filaments 3.0-4.5 mm long, subulate, glabrous, anthers *c.* 1 mm long, oblong, dorsifixed, dehiscing through both the sides; pistillodes 3, styles free, filiform, 1.5-3.0 mm long, stigma minute; discs annular, *c.* 0.5 mm high, *c.* 1 mm across, glabrous. Female flowers and fruits unknown. *Fl.* April.

Notes: This variety differs from the typical form in the following characters: leaf blades elliptic-oblong, chartaceous, shortly acuminate at apex, acumen blunt at tip, secondary nerves faint, 5-9 pairs, dividing near margin to form an intramarginal loop; inflorescence paniculate with sessile peduncle reaching up to 2 cm long; flowers dense, in 2-3 nate clusters at base, solitary towards apex; sepals and petals glandular.

The new variety is named after George Watt, who collected this interesting specimen and pointed out its distinctiveness from the typical variety.

BOTANICAL SURVEY OF INDIA,
HOWRAH - 711 103,
April 8, 1988.

K. NARAYANAN NAIR
M. P. NAYAR

37. SOME INTERESTING PLANT RECORDS FROM SIMILIPAHAR HILLS OF ORISSA

Similipahar forests in the central part of the Mayurbhanj district of Orissa, are among the most luxuriant forests of the state. The hills have an unique ecosystem which has favoured the development of a rich and varied flora. A systematic survey of the area carried out for over a period of five years has resulted in the finding of fifteen interesting plant records new to the flora of Bihar and Orissa. These are enumerated in the paper.

The plant specimens are preserved in the herbarium of the Regional Research Laboratory, Bhubaneswar.

Anaphalis adnata DC.

Meghasani, scattered among bare rocks, fl. 13.ix.1980. *Saxena & Brahmam* 4292.

Distribution: Simla to Bhutan, 1800-2400 m.; Burma, China, Philippines.

Aneilema ovalifolium (Wight) Hook. f. ex C. B. Cl.

Occasional in damp places. Chahala, fl. & fr. 17.viii.1979. *Saxena* 3773; Rajpal, fl. & fr. 2.x.1981. *Saxena & Brahmam* 4612; Barheipani — Chahala, fl. & fr. 1.x.1983. *Saxena & Brahmam* 4873. Gurguria, fl. & fr. 19.x.1983. *Saxena & Brahmam* 5186.

Distribution: Southwest India; Nilgiri Hills; Karnataka.

Blumea aromatica (Wall.) DC.

Meghasani, fl. 27.iii.1985. *Saxena & Brahmam* 5640.

Distribution: Himalaya, ascending to 1500 m.; Nepal Bhutan, Burma, Thailand, Vietnam and China.

Blumea clarkei Hook. f.

B. malabarica Hook. f.

Meghasani, along wayside, fl. 24.ii.1983. *Saxena & Brahmam* 5013.

Distribution: Kanara and Malabar.

Callicarpa longifolia Lam.

Occasional in shady forests — Bhanjabasa — Upper Barakamada, fr. 13.xi.1980. *Saxena & Brahmam* 4104; Bhanjabasa, fr. 25.ii.1983. *Saxena & Brahmam* 5050.

Distribution: Nicobars; Malaysia, Australia.

Cissus assamica (Laws.) Craib

Chingudia fall, fl. 8.v.1981. *Saxena & Brahmam* 4450.

Distribution: Assam; Bangladesh.

Colysis pedunculata (Hook. ex Grev.) Ching.

Selliguea hamiltoniana Wall.

Bhanjabase — Upper Barakamada, in shady forests, fertile 12.xi.1980. *Saxena & Brahmam* 4208, 4226.

Distribution: Bengal; Nepal, Burma, Bangladesh.

Cordia wallichii G. Don

Meghasani, fr. 25.ii.1983. *Saxena & Brahmam* 5082.

Distribution: Western India; Pakistan.

Cynanchum tunicatum (Retz.) Alston

C. pauciflorum R. Br.

Jenabil, near stream, fl. 26.viii.1982. *Saxena & Brahmam* 4904.

Distribution: Deccan Peninsula from Konkan southwards to Kerala, Sri Lanka.

Embelia floribunda Wall.

Dudurchampa, in shady valley, fl. (buds) 26.ii.1983. *Saxena & Brahmam* 5096.

Distribution: Nepal to Bhutan, 600-1800 m. Burma, Java.

Phoebe wightii Meissn.

P. paniculata Hook. f. in FBI., p.p.

Occasional along stream in shady valley-forests — Bhanjabase, fl. 23.ii.1983. *Saxena & Brahmam* 4997; Dudurchampa Badomukkabadi, fl. 27.ii.1983. *Saxena & Brahmam* 5108.

Distribution: Western Ghats, Nilgiris, Anamalais and Pulnis, in shola forests, above 1500 m.; Karnataka.

Rhaphidophora glauca Schott

Badomukkabadi, in shady forest, 28.iii.1985. *Saxena & Brahmam* 5587.

Distribution: Tropical and subtropical Himalaya from Nepal eastwards to Khasi and Manipur Hills, ascending to 2100 m.

Salomonia cantoniensis Lour.

Occasional in damp places — Bhanjabasa, fl. 14.xi.1980. *Saxena & Brahmam* 4148; Badomukkabadi, fl. 25.xiii.1982. *Saxena & Brahmam* 4776.

Distribution: Bengal, Assam, Khasi Hills, Eastern Peninsula, Malay Archipelago.

Taxocarpus kleini W. & A.

Badomukkabadi, fl. 10.vi.1982. *Saxena, Brahmam & Prabhakar Rao* 4636.

Distribution: Hills of the Deccan Peninsula, from Konkan southwards; Sri Lanka.

ACKNOWLEDGEMENTS

We are grateful to Prof. P. K. Jena, Director, Regional Research Laboratory, Bhubaneshwar for providing facilities. Thanks are due to the Similipahar Forest Development Corporation for sponsoring the survey project and providing funds for the survey tours. We also wish to thank the Director and staff of the Botanical Survey of India, Howrah for extending their co-operation for consulting the Central National Herbarium.

REGIONAL RESEARCH LABORATORY,
BHUBANESHWAR - 751 013,
February 12, 1988.

H. O. SAXENA
M. BRAHMAM

38. *BRIZA MINOR* LINN. (POACEAE) IN NORTHWEST HIMALAYA

The genus *Briza* Linn. is represented in India by three species, among which *Briza media* Linn. is common in Northwest Himalaya. The other two, *B. maxima* Linn. and *B. minor* Linn. are natives of the Mediterranean region and have been introduced into India. We wish to put on record the occurrence of *Briza minor* Linn. as wild in Northwest Himalaya. This species grows by the roadsides and in wheat fields in Kangra district of Himachal Pradesh. As no description has been provided by Hooker or Bor, a detailed description is given to facilitate the identification of this grass.

Briza minor Linn. Sp. Pl. 1: 70. 1753; Hubbard, Grasses, 185, fig. 184. 1954; Bor, Grass. Burma, Ceyl. Ind. & Pak. 528. 1960; Bor in Rech. f.,Fl. Iran. 70: 15. 1970; Gilliland in Rev. Fl. Malaya (Grasses) 3: 57. 1971; Hsu, Taiwan Grass, 307. fig. A-P., 1975; Tzvelev, Poaceae URSS. 522. 1976; Tutin, Fl. Eur. 5: 173. 1980.

English name: Lesser or Small Quaking Grass.

A loosely tufted annual, 10-70 cm high. *Culms* erect or slightly bent at the base, slender, round, smooth, 2-4 noded. *Leaves* hairless; sheaths round, smooth; ligule blunt, upto 8 mm long, membranous; blades narrowly lanceolate, finely pointed, 3-14 cm long, 3-9 mm wide, flat, finely nerved, minutely rough above and on the margins. *Inflorescence* a loose panicle, 4-20 cm long, 2-10 cm wide; branches finely divided, minutely rough, with curved hair-like pedicels 4-12 mm long. *Spikelets* nodding, compressed, orbicular to triangular-ovate, 3-5 mm long and wide or wider, 4-8 flowered, shining, green or tinged with purple. *Glumes* persistent, horizontally spreading, hooded at the apex, 2-3.5 cm long, firmly membranous, 3-5-nerved. *Lemmas* closely overlapping, similar to the glumes, very broad, cordate at the base, rounded at the top and on the back, deeply concave, becoming hardened and shining in the centre but with broad white membranous margins, hairless 7-9-nerved. *Paleas* shorter than the lemmas, flat with the two keels very narrowly winged. *Stamens* 3; anther 0.6 mm long. *Stigmas* 2, plumose. *Caryopsis* enclosed by the lemma and palea, flat in front, rounded on the back, pale-brown, 1 mm long.

Specimens examined: Himachal Pradesh, Tangroti, Kangra District, 12th March, 1980, *Asha Sharma* s.n. (DD); Palampur, Kangra district, Jan.-Feb. 1987, *R. D. Singh* s.n. **(BSD)**.

Distribution: Atlantic and Mediterranean Europe (from Britain to Greece) extending to Central Europe, Cyprus, Turkey, Syria, Lebanon, Palestine, Egypt Iran, Iraq, Pakistan, India; naturalised throughout the warmer temperate regions — USSR, China, Japan, Taiwan, Malaysia, Indonesia, Australia, Polynesia, Macaronesia, North Africa (Morocco, Algeria), South Africa, North and South America and West Indies.

Use: Occasionally grown in gardens as an ornamental grass for its delicate inflorescence.

NEW FOREST, DEHRA DUN. H. B. NAITHANI

BOTANICAL SURVEY OF INDIA,
NORTHERN CIRCLE, DEHRA DUN, B. P. UNIYAL
April 7, 1988.

39. A NOTE ON LICHEN GENUS *PROTOBLASTENIA* FROM INDIA

(*With a text-figure*)

The family Teloschistaceae, as circumscribed by Poelt (1973), includes all the genera that had previously been placed in Caloplacaceae by Zahlbruckner (1926). *Protoblastenia* is one such genus characterized by a crustose thallus, apothecia biatorine, scarlet red to red-brown, disc and exciple K+ violet-purple, and spores hyaline, single celled. The genus is represented in India by two species.

One of the species, *P. griseococcinea* (Nyl. in Hue) Inoue, was described as *Lecidea griseococcinea* Nyl. in Hue (1892) on the material collected by J. D. Hooker from granitic rocks at an altitude of about 3000 ft. (*c.* 900 m.) in the Himalayas. It is reported to be close to the following species except for its saxicolous habit. The taxon has apparently not been collected again.

The second species, *Protoblastenia russula,* is fairly common as a corticolous species widely distributed in India as detailed below.

Protoblastenia russula (Ach.) Räs.

Revist. Sudamer. Bot. 5: 67 (1938). — *Lecidea russula* Ach., Meth. Lich.: 61 (1803).

Type collection: (Tropical?) America, Swartz-not seen. (Fig. 1).

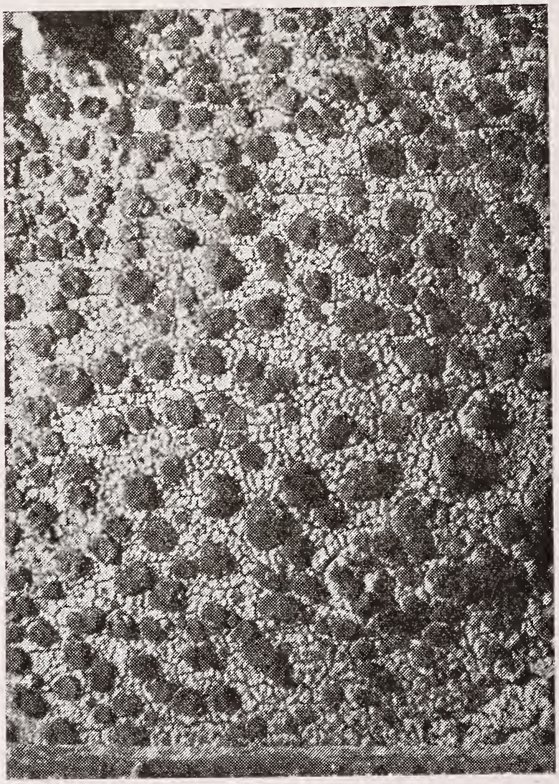

Fig. 1. *Protoblastenia russula* (Ach.) Räs. Upreti & Misra 80.126 (LWU). (Scale: 1 div. = 1 mm)

Thallus corticolous, crustose, thin, pale grey to pale brown, rimose-areolate, sometimes with minute verrucae. Apothecia scarlet-red to red-brown, (0.2-) 0.5-1 (-2) mm diam., often crowded to compact, disc plane, round to sometimes irregularly lobed in over-mature condition, margin concolorous to disc or slightly paler, distinct in young apothecia and often almost excluded in mature and lobed apothecia. Exciple pale yellow, prosoplectenchymatous, 80-100 μm thick, exterior region K+ violet-purple; epithecium orange-red to red-brown, K+ violet purple, hymenium pale yellow, 40-50 μm high, I+ blue; hypothecium hyaline to pale yellow, 20-30 μm thick, K–. Asci clavate, 34-40 × 10-12 μm, 8-spored, tholus thin, cap-like, circular to angular at the apex, I+ blue. Spores simple, hyaline, thin-walled, ellipsoid, (4–) 6-8 (–10) × 2-4 μm. Paraphyses simple, capitate. Thallus K+ yellow, C–, P+ orange.

Chemistry: Two strains by TLC: Strain I: fumarprotocetraric acid and trace of atranorin; strain II: norstictic acid and fumarprotocetraric acid (±) and trace of atranorin.

The taxon is widely distributed in tropical, subtropical to lower temperate regions of India as also in the world. It had been reported earlier from two localities from India as *Lecidea russula.*

Specimens examined:

Strain I: Madhya Pradesh, Hoshangabad district, Pachmarhi, near Apsara Vihar Falls, alt. *c.* 1080 m, 1980, Upreti & Misra 80.126 (LWU) — (Fig. 1); Meghalaya, Shillong, Laitkar forest, alt. *c.* 1650 m, 1964, Awasthi 6010, 6444 (Awas); Tamil Nadu, Nilgiri hills, Kodanad to Kilkotagiri, in shola, alt. *c.* 1800 m, 1971, Awasthi & Singh 71.86 (LWU); Nepal, Tistung, 1965, Banerjee s.n. (Awas); Central Nepal, Bagmati zone, Manichur, near herbal farm, alt. *c.* 2100 m, 1976, Sharma 76.365 (LWU).

Strain II: Karnataka, Bangalore district, Bannergatta-Hazum Kalu, alt. *c.* 980 m, 1979, Awasthi, Upreti & Misra 79.126, 79.138 (LWU); Hassan district, Sakleshpur, Sambhalli, alt. *c.* 980 m, 1979, Awasthi, Upreti & Misra, 79.355 (LWU); Mangalore district, Sakleshpur, Shiradighats on way to Mangalore, alt. *c.* 770 m, 1979, Awasthi, Upreti & Misra, 79.576 (LWU); Tamil Nadu, Palni Hills, Shembaganur, in pear orchard, alt. *c.* 1800 m, on bark of pear tree, 1970, Singh 70.865 (LWU); Nilgiri Hills, Kilkotagiri to near Konada, in shola, alt. 1800 m, 1971, Awasthi & Singh 71.19, 71.87 (LWU); West Bengal, Darjeeling district, Kalimpong division, Munsong, alt. *c.* 1500 m, on bark of *Alnus nepalensis,* 1967, Awasthi & Agarwal, 67.254 (LWU); Central Nepal, Bagmati zone, Manichur, near herbal farm, alt. *c.* 2100 m, 1976, Sharma 76.389 (LWU).

ACKNOWLEDGEMENTS

I thank Dr. D. D. Awasthi for suggestions and the Head, Department of Botany, Lucknow University for laboratory facilities. The work has been carried out as a Research Associate in the C.S.I.R. financed project "Investigations on some microlichen genera of India".

DEPARTMENT OF BOTANY,
LUCKNOW UNIVERSITY,
LUCKNOW,
April 8, 1988.

GARIMA PANT (née AWASTHI)

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40. REDISCOVERY OF A RARE FERN *MACROTHELYPTERIS ORNATA* (WALL. EX BEDD.) CHING (THELYPTERIDACEAE) IN NORTHWESTERN HIMALAYA FROM KUMAUN AFTER A CENTURY

This fern is one of the handsomest of Indian ferns and is much cultivated. It is common in northeastern India, South India, Bangladesh, Nepal, Bhutan, Sri Lanka, Malaya, Northern Australia and Polynesia. The occurrence of this species in northwestern Himalaya from Kumaun dates back to Clarke (1880) who reported it to be common from Kumaun to Bhutan in tropical valleys up to 600 m. Beddome (1883) also reported it from Kumaun to Bhutan, based on the report made by Clarke (1880). But, its being common in Kumaun Himalaya appears to be doubtful because it has not been collected since then from any part of Kumaun Himalaya by subsequent workers who reported it on the authority of Clarke (1880).

Hope (1903), while listing the known ferns of northwestern Himalaya, also included it on the authority of Clarke (1880) with this remark: "I enter this species on Mr. Clarke's authority, but I do not think it can be common in Kumaun, as he seems to say, for none of my correspondents seem to have found it there. I have not myself collected it in the low-lying valleys of Kumaun, except in that of the Gola, from about 2000 ft upwards, and I did not see it there." Further, Duthie (1906) also reported this species from Kumaun Himalaya on the authority of Clarke (1880). Recently, Dhir (1980), who enumerated all the known species of ferns from northwestern Himalaya, based on his collections coupled with earlier records of ferns from this region, also did not collect this species from Kumaun Himalaya and included it on the authority of Clarke (1880). More recently, Khullar *et al.* (1983) gave a detailed taxonomic account of the family Thelypteridaceae of Western Himalaya; they too did not see any herbarium specimen collected so far from northwestern Himalaya, and included this species on the authority of Clarke (1880). Dixit (1984) also did not mention the distribution of this species in northwestern Himalaya. It is clear from this that none of the subsequent workers could collect this species from any part of Kumaun Himalaya after Clarke (1880) in northwestern Himalaya.

During the course of explorations of Pteridophytic flora of Kumaun Himalaya, some specimens of an interesting fern were collected. After critical study, it was identified as *Macrothelypteris ornata* (Wall. ex Bedd.) Ching belonging to the family Thelypteridaceae. The collection of this species from Kumaun Himalaya in northwestern Himalaya indicates that this species is being collected after 107 years. Its rediscovery from Kumaun Himalaya is an important novelty for the fern flora of Kumaun in particular and fern flora of northwestern Himalaya in general.

In the present paper, a brief description along with other relevant information is provided to facilitate easy identification. Field number along with collector's name is given in parentheses and the voucher specimens are deposited in the Herbarium, Department of Botany, D.S.B. College, Kumaun University, Naini Tal.

Macrothelypteris ornata (Wall. ex Bedd.) Ching, Acta Phytotax. Sinica 8: 309. 1963; Khullar *et al.*, Nova Hedw. 37: 636. 1983; Dixit, Census Indian Pterid. 109. 1984. *Polypodium ornatum* Wall. ex Bedd., Ferns Brit. India 171. 1874; Clarke, Trans. Linn. Soc. Lond. 2. Bot. 1: 545. 1880; Hope, J. Bombay nat. Hist. Soc. 15: 81. 1903; Duthie, Cat. Pl. Kumaun 230. 1906. *Phegopteris ornata* J. Sm., Hist. Fil. 233. 1875; Bedd., Handb. Ferns Brit. India 294. 1883.

Rhizome erect. Stipe brown, thick, firm, robust, base densely scaly, less scaly upwards becoming rough due to persistent scale bases. Scales thin. Rhachis sparsely scaly, persistent. Lamina tripinnate, huge, lower surface of pinnules hairy, hairs short, capitate, scaly, scales very linear passing into multiseptate hairs. Pinnules slightly oblique, acuminate, deeply lobed. Veins pinnate in lobes. Sori exindusiate, 1-3 to each tertiary lobe. Sporangia with short capitate hairs. Spores brown, perinate.

Ecology: A rather rare fern that grows in open places in chir-pine mixed forests around 1300 m. It also grow on dry rock crevices in steep shady ravines along the perennial streams around 1200 m.

Specimens examined: Kumaun Himalaya: Pithoragarh district, Pomtori near Shandev around 1300 m (Samant & Rawal 929, 930); near Kukrouli village around 1200 m (Samant 936, 937).

ACKNOWLEDGEMENTS

We are grateful to Dr. S. P. Khullar, Reader, Department of Botany, Panjab University, Chandigarh for helping us in various ways and for encouragement. Thanks are due to the Head, Department of Botany, D. S. B. College, Kumaun University, Naini Tal for providing necessary facilities.

DEPARTMENT OF BOTANY,
D. S. B. COLLEGE,
KUMAUN UNIVERSITY,
NAINI TAL - 263 002.
October 20, 1987.

Y. P. S. PANGTEY
S. S. SAMANT
R. S. RAWAL

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ANNUAL REPORT OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1986-87

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HONORARY SECRETARY'S REPORT FOR THE YEAR 1986

103rd Year

MEMBERSHIP

Membership data for the past five years shows a slight fall in the Ordinary Membership and a small rise in the Life Membership. Otherwise the figures are static. 453 members paid in 1985 but did not renew their membership in 1986.

With overall increase in prices the Society is forced to revise its membership rates with effect from next Financial year i.e. 1987. The new rates would be as follows:

Particulars	Entrance fees *for new membership only* Rs.	Membership fees Rs.	Journal & Hornbill Postage Rs.	Total Rs.
Ordinary Individual Member	50.00	75.00	25.00*	150.00
Ordinary Corporate member	50.00	250.00	25.00*	325.00
Ordinary Member resident outside India (inclusive of postage on Journal and Hornbill)	£ 2.00	£15.00		£17.00
Student member (without journal)	10.00	25.00		35.00
Life Member	50.00	1200.00		1250.00
Foreign Life Member	50.00	5000.00		5050.00

	1982	1983	1984	1985	1986
Ordinary Members	1137	1533	1762	1764	1680
Corporate members	162	158	132	152	138
Life Members	407	484	562	639	737
Compound Corporate members	52	102	107	108	115
Student members	126	182	192	164	141
Honorary members	3	3	3	3	3
Vice Patrons	4	4	6	6	6
	1891	2466	2764	2833	2820

Members elected in 1986, but not paid 17

Members paid for 1985 but not paid for 1986 —453

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* If Journal and Hornbill are required under registered cover please pay an additional amount of Rs. 15/-.

MEMBERS' ACTIVITIES

Days outings:

Members were taken for a nature walk at Palghar on 25th and 26th January. A bird watching programme was arranged on a Nature trail from MAFCO to Chena Creek on 9th February and at Karnala Bird Sanctuary on 9th March. Members visited Kankeshwar on 23rd March for the study of flora and fauna. Bird watching programmes were also arranged at Sanjay Gandhi National Park-Kanheri Caves to Tulsi on 30th March. IIT Campus on 11th May and 7th Dec. Several members participated in the Nature walk at Dusk on 18th May. Nature walks were also arranged at Pongam valley on 13th July and around Tungarli lake at Lonavala on 27th July to observe flora and fauna. Bus outings were arranged to Tandulwadi on 31st August, Manek Gad on 7th September, Saras Gad on 5th October, to see flora and fauna of the areas. Bus outings are popular among members. Nature walk for monsoon flora was arranged on 28th September at Sanjay Gandhi National Park. We thank the following members and staff for leading the groups or making arrangements: Prof. P. V. Bole, Mr. M. R. Almeida, Mr. Ulhas Rane, Ms. Meena Haribal, Mr. Vaidyanathan, Dr. B. R. Dave, Mr. S. R. Nayak, Mr. Ashok Gangurde, Mr. Oswald Thayil, Mr. S. R. Shah, Mr. P. B. Shekar and Mr. N. Chaturvedi.

Week-end Camps:

These were arranged at Naneghat Jivdhan Fort on 15th and 16th February, which has at the foot of Malshej Ghat a good deciduous forest. Other week end camps were at Matheran on 15th to 17th August, at Alibag Seashore to see migratory birds on 29th and 30th November and at Suryamal on 27th and 28th December.

We are grateful to our members and staff who organised these programmes namely, Ms. Meena Haribal, Mr. Ulhas Rane, Mr. Isaac Kehimkar, Mr. Manoj Muni, Mr. P. B. Shekar and Mr. Vasant Naik.

Annual Nature Camp:

A Nature Camp was organised at Mudumalai National Park from 24th November to 2nd December 1986 for two batches each having 20 members. Mudumalai is rich in wildlife such as Elephant, Gaur, Wild dog, Tiger.

We are thankful to Mr. Oswald Thayil and Mr. Aloysius Gnanasekar for organising the camp.

The Sanjay Gandhi National Park continued to be one of the main local field activities area of the Society where members carried on field studies in various disciplines.

Popular Lectures for members were arranged on *"How to identify Bird"* for new members interested in Birdwatching on 11th January and *Bird identification* on 8th February by Dr. R. B. Grubh.

Other popular lectures were on:

"The Ecology of the Keoladeo National Park by Dr. V. S. Vijayan on 22nd March, Nature Photography by Mr. D. P. Banerjee on 17th May; Flora of Sahyadri by Mr. Ulhas Rane on 9th July. The slide show on "Dachigam to Sikkim" on 9th August by the IIT Wildlife Club; on "Tree culture" by Mr. Ashok Kumar on 13th August; Asian Elephant by Mr. Ajay Desai on 11th September; Audio Visual on Nature around Ladakh on 26th September by Sunjoy Monga and on "A field study of Tigers by Dr. David Smith on 6th September; a slide show on "African Safari" was presented by Dr. Gupta on 16th October; Mr. Shahid Ali talked on "Grey Partridge" on 31st October.

Various films courtesy British Council

(Bombay Division) were screened during the year.

Dr. Salim Ali was felicitated on 12th November (his 90th Birthday) and a seminar on various BNHS field projects was organised on 10/11 November at Bombay.

MEMBERS' FIELD RESEARCH PROGRAMMES

a) *Impact of Inchampalli and Bhopalpatnam dams*: A preliminary survey of the area to be affected by these proposed dam was done by Mr. Vijay Paranjpye of Pune. The study was supported by the SANCF and a report is available.
b) A survey of voluntary agencies engaged in environmental action was done by Mr. Gautam S. G. Vohra with the financial support from the SANCF.
c) *Upper Bhadra Project*: A preliminary survey of the proposed Upper Bhadra Project area was carried out by Mr. Ulhas Karanth to find out the impact of this project on the fauna and flora of this region.

The study was supported from the SANCF and a report is available.

Study of Infanticide in Langur, Jaipur:

A study was carried out by Dr. Reena Mathur, Assistant Professor of Zoology, University of Rajasthan with financial assistance from the SANCF and a report is available.

Density of the House sparrow populations in different habitats and its sex ratio was studied by a student of Dr. R. M. Naik with financial help from the SALWATOR Fund.

PUBLICATIONS

Journal:

During the year the December issue for 1985, Vol. 82(3) and the April and August issues for 1986, Vol. 83(1) & (2) were published. The 760 pages of these journals held 183 articles and notes. We received from members and others 384 articles and notes for publication in the Journal in 1986.

Hornbill:

Hornbill continued to maintain its popular appeal to members. Articles and the change in layout was widely appreciated. We appeal to our members to come forward to share their interesting observations/notes preferably with illustration. The Financial assistance from the Seth Purushottamdas Thakurdas Divaliba Charitable Trust is gratefully acknowledged.

Encyclopedia of Indian Natural History was released during 1986.

SALES STATEMENT

	Sales in 1985	Sales in 1986	Complimentary copies	Balance stock 31.12.86
The Book of Indian Birds	1489	1545	1	29
The Book of Indian Animals	1213	412		1866
Some Beautiful Indian Trees	186	273		821
Snake Chart	38	26	(soiled copies)	218
Checklist of the birds of Maharashtra (2nd edition)	92	101		1356
Checklist of the birds of Delhi, Agra & Bharatpur	86	81		326

A Synopsis of the Birds of India and Pakistan	31	55		1428
Grasses of Western India	38	59	4	156
Some beautiful Indian climbers and Shrubs	148	186		1874
A Pictorial guide to the Birds of the Indian Sub-Continent*	2285	1664	2	1821
A Century of Natural History	88	108	6	2109
The Book of Indian Reptiles	460	400	1	3404

* including OUP

Nature Calendar 1987-9924

Calendar and Greeting Cards: The Nature Calendar for 1987 sold 9804 and complimentary 120 copies. The greeting cards prepared and sold for the specific purpose of generating funds for supporting core scientific staff proved to be a successful endeavour.

UNIVERSITY DEPARTMENT

Following students submitted their thesis during 1986 which were accepted by the University.

	M.Sc. in Field Zoology	Guide	Financial Support
Mr. Aloysius Gnanasekar	Ecology of Amphibia of Sanjay Gandhi National Park	Mr. J. C. Daniel	Nil.
Mrs. Tara Gandhi	Bird communities of exotic tree species with special reference to *casuarina*	Dr. Salim Ali	Fellowship from Salim Ali/Loke Wan Tho Fund.

We have following students registered for M.Sc. and Ph.D. at the Society.

Mr. Shahid Ali	Ecology and behaviour of the Grey Partridge *Francolinus pondicerianus*	Dr. Salim Ali	SALWATOR
Mr. Alagar Rajan	Ecology of Spotted and Ring Doves	Dr. R. B. Grubh	Nil
Mr. Vibhu Prakash	Biology of Raptors	Dr. V. S. Vijayan	Nil
Mr. Gurmeet Singh	Ecology of Bank Myna	Dr. R. B. Grubh	Nil
	Ph.D. in Field Zoology		
Mr. U. Sridharan	Ecology of Resident Ducks in Keoladeo National Park	Mr. J. C. Daniel	Nil
Mr. Goutam Narayan	The Ecology of the Bengal Florican	—do—	Nil

Mr. S. M. Satheesan	Birds of Prey	—do—	Nil
Mr. Sunderamoorthy	The Ecology of terrestrial Birds of Keoladeo National Park, Bharatpur	—do—	Nil
Mr. Natrajan	Ecology of Crow pleasants	—do—	Nil
	Ph.D. in Plant Studies		
Mr. Manek Mistry	Contributions to the flora of Ratnagiri Dist. in Maharashtra	Prof. P. V. Bole	Nil
Mr. P. Balasubramanian	Plant/animal inter-relation	—do—	Nil
	M.Sc. in Plant Studies		
Mr. H. B. Naithani	Contribution to the Taxonomic studies of Bamboos of North Eastern India	Mr. M. R. Almeida	Nil

NATURE EDUCATION SCHEME

Nature education workshop for teachers:

A two day workshop for biology teachers was conducted on 25th and 26th September for training teachers in techniques of instructing youngsters at the Museum and Zoo.

In all 64 teachers from 40 schools participated in this workshop where the role of Museums and Zoo in education was stressed.

Environment Exhibition:

This year 19th November to 10th December was declared as environmental month by the Government. We organised an exhibition on "Forests for Prosperity" at the Society from 16th to 20th December as our contribution and it received a very good response.

About 5000 school children visited the exhibition.

The Vice President, Mr. R. Venkatraman also visited the exhibition while visiting the Society on 10th December.

Exhibition at Wada from 26th to 28th January 1987:

The All India Radio had organised their Sixth Akashvani Vidhnyan Sammelan at Wada College from 26th to 28th January 1987. Along with other Institutions BNHS was also invited to participate in the sammelan with exhibits.

A team of BNHS staff, namely Mr. Manoj Muni, Ms. Neelam Patil, and Mr. Karamble helped to arrange the exhibits of mammals, birds, reptiles and insects.

In all over 20,000 persons including students and villagers attended the exhibition in 2½ days.

In the regular activities of the scheme a total 34 field trips were conducted during the year. Among these 31 were to Borivli National Park, 2 to Karnala and 1 to Lonavala. Out of these field trips 2 were for Junior College and two for trainee teachers. 960 students from VIII to XII std. and 100 trainee teachers participated in these field trips.

Teaching through exhibits:

During the year 8 visits to Prince of Wales Museum, 7 visits to Victoria Garden and 5 visits to Aquarium were arranged. These visits were mainly for the students of Vth to VIIIth Std.

One among these was a visit to the Museum and to the Zoo for Spastic Society's children.

Talk illustrated with Slides and Film Shows:

During the year 15 talks illustrated with slides on birds, animals and insects and plants were arranged at different schools. 10 film shows were conducted in schools and colleges.

General Remarks:

This year the teachers workshop programme and the environmental exhibition received good response. Field trips were found effective and necessary as every year new students participate. It was felt that more nature orientation course for biology teachers should be held.

DONATIONS

The Society is very grateful to the following Institutions, Organisations and individuals for substantial donation towards the activities and welfare of the Society.

General donation:	
1. Dr. C. V. Kulkarni	1000.00
2. Less than Rs. 200/-	549.06
Salim Ali Nature Conservation Fund:	
1. Lady Y. P. McNeice	30,000.00
Salim Ali-Loke Wan Tho Fund:	
Cheng Kim Loke Foundation	50,000.00
Charles McCann Fund:	
1. Mr. S. Chaudhry	600.00
2. Mr. Indravan R. Mehta	2,000.00
Plant Study Fund:	
1. Mr. M. R. Almeida	750.00
Seth Purshothamdas Thakurdas Divaliba Charitable Trust (Hornbill)	25,000.00
Darbar Alkachar Charitable Trust (To cover Seminar expenses)	5,000.00

TRAINING CAMP

A birdbanding training camp was organised at Point Calimere from 24th November to 14th December for members having background of ornithology. There were 2 batches each for 10 days. Each batch was given training in netting of landbirds, waders, trapping, field identification of land birds and waders and census. We are thankful to Mr. P. B. Shekar and Dr. R. Sugathan for organising the camp.

LIBRARY

During the year 1986, 222 books were added to the Society's Library of which 168 were donated, 13 were received for review, 41 books were purchased for the Library.

We are very grateful to the British Council and the DDA for grant of books to the Library.

RESEARCH

Work at Aerodromes:

Field investigations were undertaken during this year at the following aerodromes:

1. Jammu; 2. Srinagar; 3. Madras; 4. Sirsa.

The following aerodromes were revisited during this year for updating information:

1. Gwalior; 2. Jodhpur.

In all, the BNHS team has completed field studies at 20 aerodromes as required under the project. The aerodromes are:

1. Delhi; 2. Bombay; 3. Hindon; 4. Gwalior; 5. Jodhpur; 6. Gorakhpur; 7. Dundigal; 8. Tezpur; 9. Chabua; 10. Kalaikunda; 11. Srinagar; 12. Jammu; 13. Sirsa; 14. Bangalore; 15. Trivandrum; 16. Begumpet; 17. Nagpur; 18. Calcutta; 19. Patna; 20. Madras .

Begumpet and Sirsa were not in the initial list of aerodromes to be studies but were taken up for investigation in place of Chandigarh and Adampur.

2. *Vulture Aviary at Bapna near Bombay*:

Twenty four whitebacked vultures are kept here in captivity for feeding experiments. One of the research Scientists (R. B. Singh) has been assigned to study the food requirements of vultures, the quantity and chemical composition of the excreta as well as the immunological aspects enabling vultures to consume decomposed carcasses. The study is in progress.

3. *Implementation of the Project's recommendations*:

The initial recommendations made by the Project, for Delhi, Hindon, Agra, Ambala and Bombay, in the 1st Annual Report, were accepted by the Government of India for implementation under the Seventh Five Year Plan. The minutes of the meeting of Secretaries convened on 22.1.1985 by the Cabinet Secretary for this purpose are as below:

i) In view of the numerous agencies involved in implementing various steps proposed in the *Salim Ali Report*, it was necessary for the Ministry of Defence, Air Headquarters and Department of Civil Aviation to take initiative and provide leadership in getting action plans drawn up, getting funds allocated and getting projects implemented by the different agencies. For this purpose the Environmental Management Committees should be utilised effectively.

ii) Such action plan should be formulated in respect of some more important airports to begin with, namely, Ambala, Agra and Chandigarh for which Air Headquarters will provide leadership for planning and for execution and in respect of Delhi and Bombay airports such leadership would be provided by the Department of Civil Aviation.

iii) Such plans of action should be completely drawn up before March 31, and should be introduced as an integrated Pilot Scheme in the Seventh Five Year Plan.

iv) This scheme should be centrally assisted and centrally monitored as one of the plan schemes.

4. The BNHS has requested the ARDB to finance setting up a Bird Hazard Research Cell at the BNHS to provide basic facilities and to help aviation authorities in routine bird hazard matters including identifying bird strike remnants and analysis of bird strike data.

5. Some of recent studies abroad give a vague hint that certain categories of synthesized audible sounds induce consistent fleeing response from some potential problem birds. The BNHS may consider submitting a fresh research proposal for funding from ARDB on this aspect after obtaining some more evidence to justify such an effort. A study of the effectiveness of strobe light in bird scaring is also being presently developed with the help of the M S University of Baroda.

Great Indian Bustard

In the beginning of 1986, an extensive survey was done in Rajasthan during which 104 great Indian bustards were seen. Results of this survey were published in a technical report (No. 11). This report was widely distributed, especially in Rajasthan state. A paper entitled "Movement and flock composition of the great Indian Bustard......" was published in the *Journal*, and another major paper entitled "Interspecific behaviour of the Great Indian

Bustard" was submitted to the journal for publication.

Routine work was continued at the Karera field station, Data on movement, courtship, territoriality, nesting etc. were taken. We could get permission to colour-band only two bustards. However, as the permission came very late in the season, we could catch only one bird which was colour banded.

Results of one year study at the Rollapadu field station were published in the form of annual report number 3. Some specific recommendations for conservation of bustards in Andhra Pradesh were given and the report was widely distributed in the State.

In June, the Project Scientist attended the XIX ICBP's World Conference held at Queen's University, Kingston, Canada. He read a review paper on the grassland birds of the Indian sub-continent. Later, he also attended the XIX International Ornithological Congress at Ottawa. From Canada, he went to the U.S. and saw the research facilities at the International Crane Foundation, Wisconsin, and studied the captive Kori bustards at San Diego and Washington Zoos.

Lesser Florican

Intensive field work on the lesser florican was done at Sailana, Ratlam district. As the rainfall in 1986 was normal at Sailana, upto 15 floricans were seen in our study area, and valuable data on immigration, nesting, feeding and display were collected. A census of nearby areas was done and a total of 49 male floricans were located around Sailana town. A brief survey of Rajasthan and some parts of Madhya Pradesh was done but owing to the failure of monsoon in Rajasthan, not many floricans were seen. Later, in November-December, a survey was done in Andhra Pradesh from where we have received a few reports of the floricans in winter, but we could not locate any bird. Results of the intensive studies at Sailana, and various surveys were published in the form of second annual report of this project.

Bengal Florican

Owing to the various unavoidable reasons, intensive work on the Bengal florican could not be done in 1986, except for a brief survey of West Bengal where two male floricans were located. A field station was established in Manas at the end of 1986 and the results of our studies will be published in the coming years.

Jerdon's Courser

One of the greatest achievements of the Project was the re-discovery of the Jerdon's Courser in mid-January 1986. The species was last seen in 1900. After a few months of the rediscovery, another individual was seen and photographed. Two papers about the rediscovery were published in the *Journal.* A field station was established in Sidhout area for intensive studies.

Avifauna Project

Point Calimere: Bird ringing was continued even though on a smaller scale. 5321 birds of 35 species were ringed, 103 birds of 5 different species were recaptured. Studies on biometrics of wader birds Census data and Studies on breeding residents was conducted during the year.

Project Scientist resigned during June-July 1986. The biologists have been registered for post graduate studies. Specific areas of study were assigned to them viz.

1) Study of Plant/animal inter-relation (Mr. P. Balasubramanian) at Point Calimere.
2) Studies of Mammals and Oceanic Snakes (Mr. M. Ayyadurai) at Point Calimere.

3) Study on the insectivorous bird community (Mr. V. Natarajan) at Point Calimere.
4) Study of the forest bird community (Mr. S. Alagar Rajan) at Point Calimere.
5) Study on the status and ecology of the Coastal Waders of Mandapam Peninsula and its neighbouring islands (Mr. S. Balachandran).

Mr. K. K. Mohapatra was requested to examine possibilities of bird migration studies in Orissa, and was sent to negotiate with the Orissa State Forest Dept. The Project term ended in November 1986 but was allowed to continue with leftover funds.

HYDROBIOLOGY PROJECT

The study continued as in 1985. Major findings are summarised below:

Mean annual rainfall was 364 mm and the quantum of water received from Ajan bund was 0.017 million M. Average water depth in the park was 24 to 108 cm. About 70% of the aquatic area was dry. Air temperature varied from 0.5°C to 46.5°C inside the park.

The average value of pH of the waters remained around 7.5 throughout the year; slightly more than that of 1985. The value was zero in many points. Free carbon dioxide decreased slightly; from 10.53 to 81 mg/1 of 1985 to 6.36 to 43.2 mg/1 in 1986. Values of alkalinity varied from 133.93 to 361.195 mg/1.

Phytoplanktonic surface net primary productivity varied from zero to 0.1723 mg c/m/h.

Thirty additions were made to the plant list of the park, making a total of 312 species. Among them, one species *Neptunia oleracea,* is new to Rajasthan.

Biomass of the aquatic plants showed an increasing trend; the maximum was 1022 g/m as against 905 g/m of 1985. *Paspalum distichum* continued to dominate in the biomass.

Number of macroinvertebrates of column water showed almost 50% reduction fram 1985 and, the macrobenthos also had a declining trend.

The total quantity of fish fry entering the park was 10 million, whereas it was 65 million in 1985. The source of fry in 1986 was only river Gambir, as no water was supplied from the Banganga to Ajan bund this year. The number of air-breathing fishes increased, slightly, whereas the population of gill breathers declined. Breeding of fishes in July-August was poor. Species diversity of fishes was 1.776, slightly higher than that of 1985.

Altogether, 145 pythons and seven species of turtles were recorded, adding two new records to the Rajasthan fauna.

Species diversity of aquatic birds also increased slightly; from 3.149 of 1985 to 3.534 of 1986. The 1986-87 winter population of aquatic birds was very low compared to that of 1985-86. The density during December 1986 was five times less than that of December 1985.

Breeding of the heronry species was very poor; only 610 nests were built and 78 young produced as against the 6407 nests and 6690 young of 1985. Failure of monsoon and, inadequate supply of water and fish fry were the main reasons.

Post-monsoon breeding of resident ducks was poor. Altogether, eight nests of spotbills, five nests of whistling teals and two nests of cotton teals were recorded.

Bronzewinged jacana was more common than the pheasant-tailed in the park. Only the bronzewinged bred inside the park. Breeding season was from May to September. Altogether, 38 chicks were recruited into the population. Wintering population of Siberian crane during 1985-87 was 38 with 6 juveniles, whereas it was 37 with 6 juveniles during

1985-86. The Cranes remained in block E during 1986 as there was no water in their conventional feeding areas. Substantial difference in the food and feeding habit was noticed. Feeding time increased by 10% from 1985.

The population of raptors was higher in 1985-86 than in 1986-1987. The breeding of Pallas's fishing eagle was successful with two chicks in 1986-87 but failed in 1985-86. The lesser spotted and greater spotted eagle bred in the park for the first time.

The peak periods of the species of plants in flower and fruit were in September, and April-May, while the flower and fruit abundance was more in April and May respectively.

Among the land insects, lepidepterans and hymenopterans were fewer than in 1985, whereas coleopterans and orthopterans were more. They had two peaks of abundance, a major one in August-September and a minor in March-April.

The peak period of breeding of land birds was April.

The land bird diversity increased for a short period following the fire in the grassland area. Sand-grouse and singing bush larks arrived after the fire.

Population of ungulates remained almost the same except for feral cattle (not buffaloes) whose number is on the increase.

SALIM ALI FESTSCHRIFT SEMINAR

A seminar on the field projects being conducted by the Society with Dr. Salim Ali as the Principal Investigator was held between the 10th & 12th of November 1986 as part of the programme for the celebration of Dr. Salim Ali's 90th birthday. Thirtynine papers covering various aspects of the studies being undertaken under the projects; Ecology of Keoladeo National Park; Population structure and Movements of Indian Avifauna; Endangered Species of Indian Wildlife namely Bustards, Floricans and Courser and the Ecology of the Indian Elephant were presented by research staff working on the field projects. Presentation of the papers was followed by a general discussion and there was also a review of the work undertaken on Bird Hazards to aircraft undertaken with Dr Salim Ali as Principal Investigator. The seminar was attended by members, officials of both national and International organisations concerned with the projects and the papers were well received.

Indo-British Environmental Research Programme:

A collaborative research programme between the Bombay Natural History Society (India), the Royal Society for the Protection of Birds and the Nature Conservency Council (U.K.), to be funded by the Overseas Deveolpment Authority, U.K. and sponsored by the Department of Environment, Forest and Wildlife, Government of India. Areas in which the collaborative arrangement is being considered is in the extension of the conservation education programme of the Society with a targeted audience in rural and urban areas and to set up conservation education cells, production of information packages, etc. The second field of collaboration will be for the setting up of a Tropical Forest Research Station which would attempt to create a data base for providing information on all aspects of the tropical forests of the region.

STAFF

The Committee wishes to record its appreciation of the willing co-operation of the staff in the activities of the Society.

Regd. No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE VIII VIDE RULE 17(1)

BALANCE SHEET FOR THE YEAR ENDED 31 *DECEMBER*, 1986

FUNDS & LIABILITIES		
Trust Fund or Corpus:		
Life Membership Fund (Individual):		
Balance as per last Bal. Sheet	4,71,722.61	
Add: Amount received during the year	85,681.66	5,57,404.27
Corporate Life Membership Fund:		
Balance as per last Balance Sheet	2,06,542.31	
Add: Amount received during the year	9,200.00	2,15,742.31
Vice Patron Fees		
Balance as per last Balance Sheet		42,769.00
Other Earmarked Funds:		
Created out of the income as per Schedule 'C'		29,15,841.56
Other Funds:		
As per Schedule 'A'		10,17,952.50
Liabilities:		
For unspent grant as per Schedule 'B'	25,35,323.22	
For Expenses	4,22,832.28	
For Library Deposits	1,750.00	
For Sundry Credit Balance	12,687.52	
For Advance Publications	17,559.22	29,90,152.24
Carried over		77,39,861.88

ASSETS		
Immovable Properties:		Nil
Investments: (At appropriate value)		
Govt. Securities (At cost)		
5½% Govt. of India Loan 2,000 of the face value of Rs. 2,000/- Market value (Rs. 1,990/-)	2,000.00	
3293.035 Units of the Unit Trust of India under reinvestment plan of the face value of Rs. 100/- each (Total face value Rs. 329303.50 including accumulated dividend 1298.035)	3,33,776.79	
Fixed deposit with M/s. Bharat Petroleum Corpn.	5,00,000.00	8,35,776.79
Motor Cars, Motor Cycles, Auto Cycle and Mini Bus:		
Balance as per last Balance Sheet	982.88	
Add: Value of Mini Bus donated by M/s. Tata Eng. & Locomotive Co. Limited	1,30,000.00	
	1,30,982.88	
Less: Depreciation during the year	26,196.56	1,04,786.32
Carried over		9,40,563.11

FUNDS & LIABILITIES		
Brought over		77,39,861.88
Other Advances:		
Amount received for and on behalf of the proposed Institute		
Balance as per the last Balance sheet	2,48,292.03	
Add: Interest credited during the year	22,000.00	
	2,70,292.03	
Less: Expenditure for and on account of the Instituted incurred during the year	13,758.07	2,56,533.96
Carried over		79,96,395.84

ASSETS		
Brought over		9,40,563.11
Furniture, Fixture and Equipment:		
Balance as per last Balance Sheet	88,580.41	
Additions during the year	17,259.00	
	1,05,839.41	
Less: Depreciation during the year	13,230.05	92,609.36
Loans (Unsecured considered good):		
To Employees		14,770.00
Advances (Unsecured considered good):		
To Trustees	....	
To Employees for Project expenses	2,15,049.67	
To Employees for other Society's expenses	8,048.13	
To Others	2,96,084.60	
To Nature Education Scheme	26,860.37	5,46,042.77
Suspense Account Hydrobiology Project (Considered doubtful)		28,860.15
Stocks:		
A) Publications as per inventory taken and certified by the Hon. Secretary at or below cost	6,00,920.51	
B) Safety Certridges (as certified by the Honorary Secretary)	9,530.35	
C) Publications (under preparation) Expenses incurred till date		
Book on New Indian Trees	7,126.90	
Book on Encyclopedia of India Natural History	33,278.10	6,50,855.06
Carried over		22,73,701.25

FUNDS & LIABILITIES		ASSETS		
Brought over	79,96,395.84	Brought over		22,73,701.25
		Income Outstanding:		
		Interest accrued	64,650.38	
		Supplies & Services	3,12,182.80	
		Grant-Govt. of India, Deptt. of Science & Technology for 1986-87	50,000.00	
		Grant Indian National Science Academy for 1986-87	5,000.00	
		Grant-U.S. Dept. of Interior, Fish & Wildlife Service, National Park: On the study of Ecology of certain endangered species of wild life and their habitat.	7,80,913.00	
		Grant-Govt. of India, Ministry of Defence, Aeronautic Research & Deveolpment Board for ecological study of Bird Hazards at Indian Aerodromes	8,30,838.00	
		Chief Wild Life Warden, Govt. of Jammu & Kashmir, for the project on the survey of Blacknecked Crane	87,500	21,31,084.18
		Income Tax Refundable:		16,790.00
		Cash and Bank Balances:		
		As per Schedule 'B' including Rs. 1849583.34 in fixed deposits		34,40,467.59
		Income and Expenditure Account:		
		Excess of expenditure over Income as per Income & Expenditure A/c.	1,38,080.02	
		Less: Cr. Bal. as per last Balance Sheet	3,727.20	1,34,352.82
Total	79,96,395.84	Total		79,96,395.84

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

Sd/- P. R. SARAIYA,
Honorary Treasurer,
Bombay Natural History Society

TRUSTEES

As per our report of even date
Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY, 10th *September*, 1987.

SCHEDULE 'A'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER, 1986

S. No.	*Name of the Fund*	*Balance as per last balance sheet* 1	*Amount received appropriated during the year* 2	*Interest/* credited during the year *Donation* 3	*Total of columns 1, 2 & 3* 4	*Expenditure on objects of the Society as shown in income & Exp. account.* 5	*Balance as on 31-12-1986 (4 minus 5)* 6
1.	Staff Welfare Fund	35,822.84	—	—	35,822.84	—	35,822.84
2.	Interest on Col. Burton's Nature Conservation Fund Investment	27.58	—	330.00	357.58	24.75	332.83
3.	Charles McCann Vertebrate Zoology Field Work Fund	57,752.37	—	6,352.76 (2,600/-) donation	66,705.13	3,202.85	63,502.28
4.	Salim Ali Nature Conservation Fund for Silent Valley expenses	11,341.97	—	—	11,341.97	—	11,341.97
5.	Hospitality Fund from Dr. Salim Ali	360.37	—	—	360.37	330.50	29.87
6.	Project or Fund received from Members	252.24	—	—	252.24	—	252.24
7.	Scholarship fund under Salim Ali/ Loke Wan Tho Ornithological Research Fund Investment	25,685.64	—	35,398.33	61,083.97	2,742.85	58,341.12
8.	Interest on Salim Ali Nature Conservation Fund Investment	1,32,280.54	—	69,873.42	2,02,153.96	22,742.82	1,79,411.14
9.	Interest on Field Work Fund under Pirojsha Godrej Foundation fund Investment	3,079.49	—	4,400.00	7,479.49	1,495.17	5,984.32
10.	Field Work fund — Sir Dorabjee Tata Trust	10,000.00	—	—	10,000.00	—	10,000.00
11.	For Library Books binding from Sir Dorabjee Tata Trust	3,031.94	—	—	3,031.94	3,031.94	—
	Carried over	2,79,634.98	—	1,18,954.51	3,98.589.49	33,570.88	3,65,018.61

SCHEDULE 'A' (Contd.)

S. No.	*Name of the Fund*	*Balance as per last balance sheet* 1	*Amount received/appropriated during the year* 2	*Interest/* credited during the year *Donation* 3	*Total of columns 1, 2 & 3* 4	*Expenditure on objects of the Society as shown in income & Exp. account.* 5	***Balance as on** 31-12-1986 (4 minus 5)* 6
	Brought over	2,79,634.98	—	1,18,954.51	3,98.589.49	33,570.88	3,65,018.61
12.	Field Study and Scholarship Fund from Watanmal Boolchand Charitable Trust	15,000.00	—	—	15,000.00	3,482.10	11,517.90
13.	Photography exhibition fund received from Shri M. Y. Ghorpade of Sandur	10,000.00	—	—	10,000.00	—	10,000.00
14.	Interest on Plant Study fund Investment	1,107.19	—	10,008.79	11,115.98	6,614.93	4,501.05
15.	Education & Research Fund (created out of income)	3,63,552.58	2,47,348.98	—	6,10,901.56	—	6,10,901.56
16.	Mini Bus maintenance fund (created out of income)	9,604.11	10,168.78	—	19,772.89	9,585.10	10,187.79
17.	Library Fund (created out of income)	40,000.00	—	—	40,000.00	34,174.41	5,825.59
18.	Shri R. G. Saraiya Research Grant	—	—	—	—	—	—
19.	B.N.H.S. Seminar	—	—	—	—	—	—
	Total	7,18,8898.86	2,57,517.76	1,28,963.30	11,05,379.92	* 87,427.42	10,17,952.50

**Note*

towards	Library Book Purchase	Rs. 34,174.41
,,	Library Book Binding	Rs. 3,031.94
,,	Educational objects	Rs. 50,221.07
		Rs. 87,427.42

SCHEDULE 'B'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER 1986

S. No.	*Name of Grant*	*Unspent/over spent/balance as per last bal. sheet* 1	*Amt. received/ due during year* 2	*Unspent bal. carried to next year* 3	*Income for the year as credited to Income & Exp. Account* 4	*Amount spent during the year* 5
1.	Grant Government of India, Ministry of Defence, Aeronautic Research & Development Board for ecological study of Bird Hazard at Indian Aerodromes.	88,393.12	8,30,838.00	2,74,921.23	6,44,309.89	6,44,309.89
2.	*Grants From*: U. S. Department of Interior, Fish & Wildlife Service—National Park Service:					
i)	Studies on the movement & population structure of Indian Avifauna	2,74,132.03	7,11,720.00	3,51,656.32	6,34,195.71	6,34,195.71
ii)	Hydrobiological (Ecological) Research Station at Keoladeo Ghana Sanctuary, Bharatpur	1,69,557.82	9,24,255.00	3,08,405.60	7,85,407.22	7,85,407.22
iii)	Study of Ecology of certain endangered species of wildlife and their habitats	1,950.21	7,80,913.00	2,54,894.60	5,27,968.61	5,27,968.61
iv)	Study of Lesser Bustard (Florican) *Sypheotides indica* and the Bengal Florican *Eupodotis bengalensis*	89,698.53	4,10,407.00	2,18,477.10	2,81,628.43	2,81,628.43
3.	Grant from Chief Wildlife Warden, Chandigarh, Punjab, for Bird Ringing Project at Harike	59,316.26	—	55,027.36	4,288.90	4,288.90
	Carried over	6,83,047.97	36,58,133.00	14,63,382.21	28,77,798.76	28,77,798.76

SCHEDULE 'B' (Contd.)

S. No.	*Name of Grant*	*Unspent over spent balance as per last bal. sheet* 1	*Amt. received/ due during year* 2	*Unspent bal. carried to next year* 3	*Income for the year as credited to Income & Exp. Account* 4	*Amount spent during the year* 5
	Brought over	6,83,047.97	36,58,133.00	14,63,382.21	28,77,798.76	28,77,798.76
4.	Grant from Chief Wildlife Warden, Bhubaneshwar, Orissa, for Bird Ringing Project at Chilka	6,110.86	—	2,689.97	3,420.89	3,420.89
5.	Grant Government of India, Dept. of Environment, for the expenses on Secretarial Assistance to Dr. Salim Ali for environmental research programme for processing Archival Material	355.88	25,000.00	3,753.38	21,602.50	21,602.50
6.	Grant Government of India, Dept. of Culture, for publishing the Centenary Seminar papers of the Society 1984-85 contd. till 1986-87.	29,764.90	—	29,657.45	107.45	107.45
7.	Grant Govt. of India, Dept. of Science & Technology, for the publication of Encyclopedia of Indian Natural History 1984-85 contd. 1986-87	99,214.70	—	—	99,214.70	99,214.70
8.	Grant Govt. of India, Dept. of Environment for Air Conditioning the Hornbill House, Library and Collection rooms.	9,00,000.00	—	8,14,150.00	85,850.00	85,850.00
9.	Grant Govt. of India, Dept. of Science and Technology for the publication of Journal during 1986-87	—	50,000.00	—	50,000.00	50,000.00
10.	Grant Indian National Science Academy for the publication of Journal 1986-87	—	5,000.00	—	5,000.00	5,000.00
11.	Grant from Chief Wildlife Warden, Jammu & Kashmir for the Project on survey of Blacknecked Crane	—	1,65,000.00	83,027.45	81,972.55	81,972.55
	Carried over	17,18,494.31	39,03,133.00	23,96,660.46	32,24,966.85	32,24,966.85

SCHEDULE 'B' (Contd.)

S. No.	Name of Grant	Unspent/over spent/balance as per last bal. sheet 1	Amt. received/ due during year 2	Unspent bal. carried to next year 3	Income for the year as credited to Income & Exp. Account 4	Amount spent during the year 5
	Brought over	17,18,494.31	39.03.133.00	23,96,660.46	32.24,966.85	32,24,966.85
12.	Grant from Seth Purushottamdas & Divaliba Charitable Trust for *"The R. G. Saraiya Research Grant"*.	—	25,000.00	25,000.00	—	—
13.	Specific donation from Darbar Alkachar Charitable Trust for Seminar Expenses	—	5,000.00	5,000.00	—	—
14.	Grant Govt. of Maharashtra for Establishment & Building Maintenance :					
	1) for 1985-86	39,019.20	—	—	39,019.20	39,019.20
	2) for 1986-87	—	—	—	—	—
15.	Grant Govt. of Maharashtra for Building repairs for 1984-85 contd. till 1986-87	1,12,782.76	—	1,08,662.76	4,120.00	4,120.00
	Total	18,70,296.27	39,33,133.00	25,35,323.22	32,68,106.05	32,68,106.05*

**NOTE*

		Rs.
Towards	Property expenses	4,120.00
,,	Establishment	39,019.20
,,	Educational Objects	31,69,966.85
,,	Journal expenses	55,000.00
		32,68,106.05

SCHEDULE 'C'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER 1986

Sl. No.	*Name of the Funds*		*Balance as per last Balance Sheet* 1	*Received during the year* 2	*Total of Column 1 & 2* 3	*Transfer to income & Exp. A/c. as shown in the Income & Exp. A/c.* 4	*Balance as on 31-12-1986* 5
1.	Fixed Assets Fund		30,078.57	1,42,659.00	1,72,737.57	39,426.61	1,33,310.96
2.	Building Fund		1,03,227.68	11,000.00*	1,14,227.60	11,000.00	1,03,227.68
3.	General Reserve Fund		37,952.71	—	37,952.71	—	37,952.71
4.	Provision for Depreciation on Investment		9,266.10	—	9,266.10	—	9,266.10
5.	Provision for Capital losses		15,025.23	—	15,025.23	—	15,025.23
6.	Publication Fund (BNHS)		8,84,317.36	—	8,84,317.36	—	8,84,317.36
7.	Govt. of India, Dept. of Science & Technology Publication Fund:						
	i) Sale Proceeds of Century of Natural History	5,459.76					
	ii) Sale Proceeds of Indian Reptiles	13,932.37					
		19,392.13	92,797.27	19,392.13	1,12,189.40	—	1,12,189.40
8.	Salim Ali/Loke Wan Tho Ornithological Research Fund.		3,21,136.52	52,000.00	3,73,136.52	—	3,73,136.52
9.	Col. Burton's Nature Conservation Fund		3,000.00	—	3,000.00	—	3,000.00
10.	Sir Pirojsha Godrej Foundation Field Work Fund		40,000.00	—	40,000.00	—	40,000.00
11.	Salim Ali Nature Conservation Fund		6,35,212.99	30,000.00	6,65,212.99	—	6,65,212.99
12.	Plant Study Fund		90,989.24	750.00	91,739.24	—	91,739.24
13.	Staff Gratuity Fund		2,82,510.80	31,076.18*	3,13,586.98	5,464.00	3,08,122.98
14.	Centenary Celebration Fund		89,340.39	—	89,340.39	—	89,340.39
15.	Hornbill Newsletter Fund		50,000.00	5,500.00*	55,500.00	5,500.00	50,000.00
	Total		26,84,854.86	2,92,377.31	29,77,232.17	61,390.61	29,15,841.56

* Interest

SCHEDULE 'D'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING THE PART OF BALANCE SHEET AS AT 31ST DECEMBER 1986

CASH AND BANK BALANCE:

A) *In Current Account with:*		
i) Grindlays Bank Plc, M. G. Rd., Bombay 400 023	4,41,975.64	
ii) Grindlays Bank Plc, London (£2,451.78) @ Rs. 18.35	44,990.16	
iii) Chartered Bank, M. G. Road, Bombay 400 023	4,98,664.33	9,85,630.13
In Savings Account with:		
iv) Grindlays Bank Plc, M. G. Rd., Bombay 400 023	1,55,437.73	
v) Bank of India, Museum Savings Br., Bombay 400 023	47,489.98	
vi) Bank of Baroda, University Br., M. G. Road, Bombay 400 023	1,62,807.79	
vii) Corporation Bank, Dalal St. Branch, Bombay 400 023	2,39,518.62	6,05,254.12
B) *In Fixed Deposit with:*		
i) Bank of India, M. G. Road, Bombay 400 023	1,19,583.34	
ii) Chartered Bank, M. G. Road, Bombay 400 023	1,00,000.00	
iii) Bank of Baroda, University Br., M. G. Road, Bombay 400 023	1,00,000.00	
iv) Corporation Bank, Dalal St., Bombay 400 023	6,00,000.00	
v) Grindlays Bank Plc, M. G. Rd., Bombay 400 023	1,55,000.00	
C) *In Monthly Income Certificate with:* Bank of India, M. G. Road, Bombay 400 023	7,75,000.00	18,49,583.34*
Total		34,40,467.59

* Including earmarked against the following funds:-

1) Dr. Salim Ali/Loke Wan Tho Ornithological Res. Fund	3,73,136.00
2) Dr. Salim Ali Nature Conservation Fund	6,65,212.00
3) Pirojsha Godrej Foundation Field Work Fund	40,000.00
4) Charles McCann Vertebrate Zoology Field Work Fund	63,502.00
5) Building Fund	1,00,000.00
6) Staff Gratuity Fund	3,08,122.00
7) Hornbill Newsletter Fund	50,000.00
8) Plant Study Fund	91,739.00
9) Col. Burton's Nature Conservation Fund	3,000.00
Total	16,94,711.00

Regd. No. F. 244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUST ACT, 1950

SCHEDULE VIII VIDE RULE 17(1)

INCOME AND EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31*ST DECEMBER*, 1986

	EXPENDITURE		
To	*Expenses in Respect of Properties*:		
	Rates & taxes	4,826.00	
	Insurance (on Building)	266.00	
,,	*Other Contingency Expenses*: Contingency expenses, Electricity charges, etc. including Rs. 11,000/- charged to Building Fund (as per Contra)	28,851.70	
,,	*Repairs & Maintenance*: Met out of grant Govt. of Maharashtra for 1984-85 contd. till 1986-87.	4,120.00	38,063.70
,,	*Establishment Expenses*:		
	A) Salaries including D.A. etc. met out of grant Govt. of Maharashtra for 1985-86 (as per Schedule 'B')	39,019.20	
	B) Salaries including D.A. etc. for Reference Collection Staff for the period 1-4-1986 to 31-12-1986	1,29,750.45	
	Carried over	1,68,769.65	38,063.70

	INCOME		
By	*Rent* (Accrued and realised):		
,,	*Interest* (Accrued and realises):		
	On Securities	641.25	
	On Fixed deposits and Bank A/c. (including Rs. 1,95,939.48 on earmarked funds)	2,88,247.34	2,88,888.59
,,	Dividend (on Units of Unit Trust of India under reinvestment plan)		40,036.37
,,	*Donations* (in cash or kind):		
	i) *For specific funds*:		
	Charles McCann Vertebrate Zoology Field Work Fund	2,600.00	
	Dr. Salim Ali Nature Conservation Fund	30,000.00	
	Dr. Salim Ali/Loke Wan Tho Ornithological Research Fund	52,000.00	
	Plant Study Fund	750.00	
	Fixed Assets Fund (including value of Mini Bus received as donation from Tata Eng. & Locomotive Co. Ltd. in the earlier year)	1,42,659.00	
	Carried over	2,28,009.00	3,28,924.96

EXPENDITURE		
Brought over		38,063.70
,, *Establishment Expenses* (Contd.):	1,68,769.65	
C) Salaries including D.A. etc. other than above including Rs. 14,445.15 for Plant Study Staff	4,85,536.69	
Society's Contribution to staff Provident Fund	17,208.00	
Postage	11,366.35	
Printing and Stationery	29,309.10	
Advertisement	633.00	
Telephone Rental and Call charges	10,496.35	
Meeting expenses	9,691.55	
Conveyance and travelling expenses	6,745.25	
Bank Charges	1,485.44	
Wages (Local labour)	425.00	
Medical expenses to staff members	8,208.00	
Leave travel expenses to staff members	14,527.20	
Gratuity paid to employees	5,464.00	7,69,865.58
,, *Audit Fees*:		1,000.00
,, *Amounts written off*:		
Bad debts		737.25
Carried over		8,09,666.53

INCOME		
Brought over		3,28,924.96
By *Donations* (in cash or kind) Contd.:	2,28,009.00	
ii) General donations	1,549.06	
iii) From Seth Purushottamdas Thakoredas Divaliba Charitable Trust towards publication of Hornbill Newsletter	25,000.00	
iv) Life membership contributions individuals	85,681.66	
v) Corporate Life membership contributions	9,200.00	3,49,439.72
,, *Grants*: As per Schedule 'B'		32,68,106.05
,, *Income from subscriptions and Entrance Fees*:		
Membership Subscriptions (Individual)	1,19,652.36	
Student Membership subscription	2,445.00	
Corporate Membership subscriptions	36,132.00	
Subscription to Journal (Non members)	45,013.95	
Entrance fees	11,660.00	2,14,903.31
,, *Income from Publications*:		
Journal Sales	4,668.22	
Book of Indian Birds	26,518.31	
Book of Indian Animals	16,369.90	
Some Beautiful Indian Trees	4,760.00	
Some Beautiful Indian Climbers and Shrubs	5,455.20	
Identification of Poisonous Snake charts	100.00	
Synopsis of the Birds of India & Pakistan	1,807.50	
Grasses of Western India	1,309.50	
Hornbill Stickers	381.00	
Carried over	61,369.63	41,61,374.04

EXPENDITURE			
Brought over			8,09,666.53
To *Miscellaneous Expenses*:			
General Contingency expenses		5,658.83	
Insurance Premium Fire & Accident		2,343.00	
Repairs to furniture and equipment		5,214.84	
Garden Maintenance expenses		900.00	
Retainers fees		1,500.00	
Professional fee (M/s. Habib & Co. re. Income tax)		4,000.00	19,616.67
„ *Depreciation*:			
On Furniture and Equipment		13,230.05	
On Motor Cars, Motor Cycle, Mini Bus and Auto Cycle		26,196.56	39,426.61
„ *Amounts transferred to Reserve or Specific Funds*:			
i) Life Membership Fund contributions received during the year		85,681.66	
ii) Corporate Life Membership Fund contributions received during the year		9,200.00	
iii) Other Funds: as per Schedule 'A'			
Specific Donations	2,600.00		
Interest on earmarked investments/deposits	1,26,363.30	1,28,963.30	
Carried over		2,23,844.96	8,68,709.81

INCOME			
Brought over			41,61,374.04
By *Income from Publications* (Contd.):			
B/o.		61,369.63	
Nature Calendars		56,709.65	
Other Publications		7,650.27	
Book of Indian Reptiles		13,932.37	
A Century of Natural History		5,459.76	
Greeting Cards		2,47,348.98	3,92,470.66
„ *Miscellaneous Income*:			
Miscellaneous receipts (General)		3,155.58	
Nett receipts received from members Nature Camps arranged during the year			
Total receipts	Rs. 45,130.00		
Less expenses	Rs. 34,961.22	10,168.78	
Exchange Fluctuation Grindlays Bank A/c. London		2,090.41	
Fees for the use of transperencies		17,150.00	32,564.77
„ *Administrative Fees*:			
For handling Greeting Card Sales Account		33,620.47	
For handling Century of Natural History Publication Sales		1,448.10	
For handling Book of Indian reptiles publication sales		3,259.05	
For handling project funds		2,98,087.90	
For handling other earmarked funds		10,583.02	3,46,998.54
Institute			49,33,408.01

EXPENDITURE			
Brought over			8,68,709.81
To *Amount transferred to Reserve or Specific Fund*: Contd.			
B/o		2,23,844.96	
iv) Earmarked funds as per Schedule 'C'			
Specific donations	2,25,409.00		
Interest on ear-marked investments/deposits	47,576.18		
Sale proceeds of specific publications	19,392.13	2,92,377.31	
v) Interest credited to proposed Institute		22,000.00	5,38,222.27
,, *Appropriations to Specific Funds*:			
i) Education and Research Fund: Surplus from Greeting Cards		2,47,348.98	
ii) Mini Bus maintenance: Surplus from Nature Camps		10,168.78	2,57,517.76
Carried over			16,64,449.84

INCOME		
Brought over		49,33,408.01
By *Amount Transferred to Specific Funds*:		
From Building fund towards expenditure on Building maintenance	11,000.00	
From Hornbill Newsletter fund expenditure on Hornbill Newsletter publication	5,500.00	
From Fixed Assets Funds towards depreciation (per contra)	39,426.61	
From various specific funds towards expenses on objects of the trust — As per Schedule 'A'	87,427.42	
From Staff Gratuity fund for payment of gratuity to staff member.	5,464.00	1,48,818.03
Carried over		50,82,226.04

EXPENDITURE			INCOME	
Brought over		16,64,449.84	Brought over	50,82,226.04
To *Expenses on Objects of the Trust:*			By Excess of expenditure over Income transferred to Balance Sheet	1,38,080.02
i) Educational: Met from respective funds as per Schedule 'A'	50,221.07			
ii) Expenses met out of grants on objects of the trust as per Schedule 'B'	31,69,966.85			
ii) For publishing the Journal of the Society (includes Rs. 55,000/- met from specific grants as per Schedule 'B')	2,05,496.15			
iv) For publishing Hornbill Newsletter (includes Rs. 25,000/- met from specific donations)	76,478.25			
,, *Library Account:**				
Subscription to other Societies	3,489.62			
Purchase of Books	34,174.41			
Book binding expenses (*inclusive of Rs. 37,206.35 met out of respective funds as per Schedule 'A')	4,258.50	35,44,084.85		
To *Field Study Programme & other Field Study expenses and members activity*		5,915.77		
,, *Maintenance of Reference collections*		5,855.60		
Total		52,20,306.06	Total	52,20,306.06

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

Sd/- P. R. SARAIYA,
Honorary Treasurer,
Bombay Natural History Society

TRUSTEES

As per our report of even date
Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY, 10th *September,* 1987.

BOMBAY NATURAL HISTORY SOCIETY
NATURE EDUCATION SCHEME
RECEIPTS AND PAYMENTS ACCOUNT FOR THE YEAR ENDED 31*ST DECEMBER*, 1986

RECEIPTS		
To *Balances as at* 1*st Jan.* 1986		
1. With Grindlays Bank Plc.	433.86	
2. With Nature Education Organiser	200.00	633.86
„ *Grants*:		
Govt. of Maharashtra for the year 1985-86		27,240.00
„ *Sale of Nature Study Booklets*		281.25
„ *Advance from Bombay Natural History Society*		26,860.37
Total		55,015.48

PAYMENTS		
By refund of advance to Bombay Natural History Society		17,141.62
Salaries (Nature Education Organiser)		25,914.45
Printing & Stationary a/c.		2,699.60
General charges a/c.		1,894.95
Postage a/c.		430.35
„ *Balance as at* 31*st Dec.* 1986		
1. With Grindlays Bank Plc, Bombay	6,734.51	
2. Cash on hand with Nature Education Organiser	200.00	6,934.51
Total		55,015.48

Sd/- A. N. D. NANAVATI,
Honorary Secretary,
Bombay Natural History Society

Sd/- P. R. SARAIYA,
Honorary Treasurer,
Bombay Natural History Society

TRUSTEES

As per our report of even date
Sd/- HABIB & Co.,
Chartered Accountants

BOMBAY, 10th *September*, 1987.

THE ANNUAL GENERAL MEETING OF THE BOMBAY NATURAL HISTORY SOCIETY FOR THE YEAR 1986-87 WAS HELD ON FRIDAY, THE 18TH DECEMBER, 1987 AT HORNBILL HOUSE AT 6.00 P.M., WHEN THE FOLLOWING WERE PRESENT:

1. Mr. Justice M. Hidayatullah (in the Chair)
2. Mr. Humayun Abdulali
3. Mr. Bansi Mehta
4. Prof. P. V. Bole
5. Dr. (Ms) Meena Haribal
6. Mr Kiran Parekh
7. Mr. T. V. Jose
8. Mr. Anil D. Kunte
9. Dr. Pratap Saraiya
10. Mr. J. C. Daniel
11. Mr. Sejal Worah
12. Dr. A.N.D. Nanavati
13. Mr. Raju D. Shinde
14. Mr. M. R. Almeida
15. Mr. B. Menezes
16. Mr. H. K. Divekar
17. Mr. M. P. Behramfram
18. Mrs. D. S. Variava
19. Ms. Heta Pandit
20. Ms. Rita Ganguli
21. Mr. Debi Goenka
22. Ms. Uma Roy Choudhury
23. Mr. A. M. Bhagwat
24. Mr. Y. V. Jhala
25. Mr. J. P. Irani
26. Mr. Shahid Ali
27. Mr. S. G. Majumdar
28. Ms. Tvisha Desai
29. Ms. Shashi Rekha Iyer
30. Mr. N. D. Sethna
31. Mr. Ranjit Manakadan
32. Mr. Prakash Rao
33. Mr. T. V. Sourirajan
34. Mr. S. F. Tarapore
35. Mr. Zaveer Contractor
36. Mr. N. C. Chhaya
37. Mr. A. V. Ghangurde
38. Mr. N. D. Mulla
39. Mr. R. Viswanathan
40. Mr. Vasant Gandhi
41. Mr. Sam Bhacka
42. Mrs. Phillippa Mukherjee
43. Dr. Robert Grubh
44. Dr. V. S. Vijayan
45. Mr. S. T. Tambe
46. Mr. Ulhas Rane
47. Mr. S. Chandrasekhar
48. Mr. S. Alagar Rajan
49. Mr. Mihir Devari
50. Mr. Cyrus Guzder
51. Mr. Suresh G. Bhatkal
52. Mr. Shyam Chainani
53. Mr. D. I. Solanki
54. Mr. D. N. Mistry
55. Mr. O. S. Fernandes
56. Ms. Shomita Mukherjee
57. Mr. P. H. Butani
58. Mr. T. V. Prabhakar
59. Mr. K. P. Karamchandani
60. Mr. S. A. Hussain
61. Mr. Bittu Sahgal
62. Mr. C. K. Rele
63. Mr. M. D. Agharkar
64. Mr. S. R. Burman
65. Mr. V. V. Shingre
66. Mr. V. James
67. Dr. E. K. Bharucha
68. Mr. K. B. Somaiya
69. Mr. Y. P. Bhatt
70. Mr. J. B. Dave
71. Mr. Umesh P. Banere

72. Mr. Sunil R. Zaveri
73. Mr. Hirji C. Mistry
74. Ms. F. Nazareth
75. Mr. Chandrakant Wakankar
76. Mr. S.D.N. Parekh
77. Mr. O. J. Fonseca
78. Mr. D. B. Jamdade
79. Mr. Carl D'Silva
80. Mr. Ravi Sankaran
81. Mr. Nitin Jamdar
82. Mr. D. M. Dumasia
83. Sanctuary Magazine

Mr. N. D. Mulla raised the point that by a resolution of the Annual General Meeting of 1985 the minutes of the previous A.G.M. should be formally adopted at this meeting. This should be the first item on the agenda.

The Honorary Secretary informed the audience that the draft minutes were circulated to all members present at the meeting but no comments were received. Mr. N. D. Mulla made a point that the said minutes were not received by him. The President assured that care would be taken in the future, and the said minutes were accepted.

The Annual Report for the year 1986-87 was then taken up, and the President enquired if the members had any comments on the report which had been circulated.

Mr. N. D. Mulla raised the point that the Annual Report was not circulated to all members. The Honorary Secretary informed the audience that because of the unfortunately high postage cost involved, copies of the Annual Report could not be posted to every member prior to the AGM. However, it is made available at the Society prior to the holding of the meeting where interested members could go over it, as also it could be arranged to be posted to such members as requested it.

Mr. N. D. Mulla drew attention of the Chair to the Centenary issue of the Society's *Journal,* and pointed out that the article "An experience of Wildlife Photography" by M. Y. Ghorpade at page 147 therein contained no more than portions lifted by the author from his book on Wildlife Photography. Mr. Mulla pointed out that this did not do credit to a prestigious journal like the Bombay Natural History Society's Journal, and it is unexplainable that the Editors of the *Journal* could not detect it. He pointed out how essential the proposition to introduce an Editorial Panel was to assist the three editors. He also pointed out that the Miscellaneous Notes section of the said *Journal* issue did not contain any notes on insects, and asked the reason for this omission.

After some discussion, Prof. P. V. Bole, one of the Editors of the *Journal,* stated that the formation of an Editorial Board would be considered. Mr. J. C. Daniel apologised for the absence of Entomological Notes in the Miscellaneous section which was an oversight.

The Honorary Secretary then informed the audience of the main events for 1987:

1. The demise of Dr. Salim Ali on 20 June 1987, on which occasion a BNHS condolence meeting was held.
2. His bequest of Rs. 7.5 lacs to the Society for forming a Chair in Ecology and Natural History.
3. Starting of the Salim Ali Memorial Fund to sponsor independent research.
4. The Society's Committee took the decision to appoint some senior staff of the Society as permanent scientists to channel and develop the scientific programmes of the Society.
5. From October 1st the Sole Selling Agency of the Society's publications has been entrusted to the Oxford University

Press and we hope thus to boost up our sales.

6. The appointment of the new Honorary Treasurer, Dr. Pratap Saraiya. He has already made an impact on our accounts and we hope he would be our Treasurer for a long time to come.
7. Four new projects have been accepted by the Government of India for funding by the U.S. Fish and Wildlife Service for 3-5 years.
8. The Society has been awarded the Indira Gandhi Paryavaran Puraskar which carries a cash award of one lakh rupees and a trophy. The trophy was displayed to members.

The acceptance of the Honorary Secretary's Report was proposed by Mr. Debi Goenka and seconded by Mr. Cyrus Guzder.

The President called upon the Honorary Treasurer to present the statement of accounts which had been circulated and invited comments from members.

Mr. Bansi Mehta referred to the deficit of Rs. 1,38,000/- and enquired if it was caused by the non-receipt of grant from the Government of Maharashtra and was answered by the Honorary Treasurer in the affirmative. The President explained that by the referendum the members have accepted the condition of having representation on the Society's Executive Committee from the Government, and this would assist in receiving the grant from the Government.

Mr. Mehta questioned about the item of Rs. 28,000/- defalcated from the Hydrobiological Project. The Honorary Treasurer stated that the final report of the enquiry has been submitted, and we have agreed to write it off from the next year's accounts. Every effort including report to the police had failed.

Mr. N. D. Mulla referred to Rs. 8000/- outstanding against Mr. P. B. Shekar and as to why it was allowed to be outstanding so long. Mr. Mulla was informed by the Honorary Treasurer that the amount was an advance to Mr. P. B. Shekar to organise the Snake Exhibition at India Fair in the U.S.A. This did not materialise. The amount was considered recoverable from the Smithsonian Institution. Negotiations in this direction were going on.

Mr. Mulla raised the question of Rs. 6 lacs realised from the sale of greeting cards. He pointed out that at the last meeting the amount was said to be used for tiding over the gaps which occurred at the time the project funds were exhausted. He stated that this had not been necessary as new project had been approved and that these funds should not be allowed to remain idle. While the Honorary This did not materialise. The amount was Treasurer assured that these monies would not be kept idle. Mrs. D. S. Variava explained to the audience that now the project funds have been received and the amount would be invested.

The accounts were put to vote, and were passed: Mr. Bittu Sahgal proposing adoption, seconded by Mr. Debi Goenka.

As regards the appointment of Auditors, Mr. Debi Goenka proposed and Mr. Guzder seconded the name of Messrs Habib & Co. but left it to the discretion of the Executive Committee to fix their remuneration.

Election of the Committee: Since two nominations had been received for election to the Committee in addition to the panel of 12 names proposed by the outgoing Committee, it was announced that an election would be held.

The matter of revision of the Society's rules was now taken up. Mr. N. D. Mulla pointed out that the time given to study the amended rules was insufficient. Moreover he pointed out that these amendments were to put up within six months of the AGM of the year 1985-86, but this was not done. Enquiries at the office after receiving the notice to see the amended rules elicited the reply that they were not ready. He objected to taking up of the rules for consideration at this meeting, but suggested that a General Body meeting be held on or before 18th February for the purpose of discussing them and their amendment.

The President pointed out that amending of the rules was an immediate necessity, as in response to the referendum Government representatives had to be accommodated on the Executive Committee. Such being the case, the Meeting agreed to accept Rule 31 (28) presented as amended in the schedule with the sub-clause (4) 'the chief paid executive of the Society (ex officio)' which had not been discussed earlier postponed.

It was agreed to delete Rule 63 (old rules) requiring a security deposit from persons appointed to handle cash in the service of the Society, as we were now relying on Fidality Insurance for this purpose.

Mrs. D. S. Variava moved a vote of thanks to the Chair which was unanimously accepted, and the meeting terminated.

In the ballot held in February 1988, the following were elected to the Executive Committee:

Mr. M. R. Almeida
Dr. Erach K. Bharucha
Dr. B. F. Chhapgar
Mr. Cyrus J. Guzder
Dr. (Ms.) Meena Haribal
Mr. Kisan Mehta
Dr. A. N. D. Nanavati
Prof. Parvish K. Pandya
Mr. Ulhas Rane
Dr. Pratap Saraiya
Mr. Digveerendrasinhji Indrasinhji Solanki
Mrs. D. S. Variava

AN EXTRA-ORDINARY GENERAL MEETING OF THE SOCIETY WAS HELD ON SATURDAY THE 26TH MARCH 1988 AT 6.00 P.M. AT HORNBILL HOUSE

The following were present:

1. Mr. Justice M. Hidayatullah (President, In the Chair)
2. Mr. Humayun Abdulali (Vice President)
3. Dr. A. N. D. Nanavati (Hon. Secretary)
4. Mr. Bansi Mehta
5. Mr. M. M. George
6. Mr. B. Menezes
7. Mr. Arun Mohile
8. Ms. Tvisha Desai
9. Mr. Ulhas Rane
10. Dr. J. H. Thakkar
11. Mr. Shahid Ali
12. Mr. N. P. Behramfram
13. Mr. Sudhakar Solomoneraj
14. Mr. Sunil R. Zaveri
15. Ms. Uma Roychoudhury
16. Mr. N. D. Mulla
17. Mr. Sanat Burman
18. Mr. N. D. Sethna
19. Mr. S. D. Bhaumik
20. Dr. Jay Samant
21. Mr. Debi Goenka
22. Ms. Heta Pandit
23. Mr. Asad Akhtar
24. Dr. (Ms.) Meena Haribal
25. Ms. Sanskruti Vaidya
26. Mr. Vasant Gandhi
27. Mr. S. A. Hussain
28. Dr. R. B. Grubh
29. Prof. Parvish Pandya
30. Mr. S. P. Kamath
31. Mr. Carl D'Silva
32. Ms. Iyer Sashirekha
33. Dr. Pratap Saraiya (Hon. Treasurer)
34. Mr. Cyrus Guzdar
35. Lt. Col. D. B. Phadkar
36. Mr. Ulhas Paralkar
37. Mr. V. James
38. Mr. Y. V. Jhala
39. Mr. M. K. Mistry
40. Mr. Sunjoy Monga
41. Mr. Nitin Jamdar
42. Dr. Asad Rahmani
43. Mr. Kiran Srivastava
44. Mr. Edward Gomes
45. Mr. Zareer Contractor
46. Prof. P. V. Bole (Vice-President)
47. Mr. Y. P. Bhatt
48. Mr. Sam Bhacka
49. Ms. S. Tarapore

At the outset the President explained that there were a number of proposed amendments about which no further suggestions had been received from members. These would not be discussed at the meeting but would be adopted as already circulated.

Among the rules on which suggestions were received there were some requiring minor or verbal changes. These could be discussed and adopted according to the sense of the house. Those rules regarding which there were marked differences of opinion would be held over and would, if thought advisable, be the subject of a referendum.

The meeting then proceeded to consideration of the rules in respect of which suggestions had been received.

Rule 1. Mr. Bansi Mehta's suggestion that the words "of either sex" in line 3 are not relevant today was accepted, and it was agreed that these words be deleted.

Mr. N. D. Mulla's suggestion that a sentence be added to para 2 to define student members was accepted. The Executive Committee was directed to make the necessary amendments.

Rule 2. Mr. Bansi Mehta pointed out that the word "admission" was used in this rule whereas the word "elected" was used in other rules. It was agreed that a uniform phraseology should be adopted and the Executive Committee would make necessary changes.

Rule 7. Mr. Bansi Mehta suggested that all funds be capitalized and only the interest on these be used as revenue. The Hon. Treasurer stated that it was necessary to have a proper balance between corpus funds (of which only the interest could be used) and other funds, having regard to the requirements, including working capital, of the Society. The Hon. Treasurer added that he had submitted proposals in this regard to the Executive Commitee. The suggestion that "all funds" be capitalised was not accepted in view of the matter being before the Executive Committee for consideration.

Rule 8. Mr. N. D. Mulla's suggestion that the old Rule 10 be retained and renumbered 8A was accepted.

Rule 14. The proposal of Mrs. Almitra Patel that the number of Honorary Members be increased to 50 was not considered necessary, as even the present provision of 15 Honorary Members has not been filled up.

Rule 17. Mr. Mulla's amendment to insert in line 3, after "Society", the word "and to attend meetings and functions of the Society", was accepted.

Rule 19. Mr. Bansi Mehta pointed out that Compound Corporate Members should be included after Life Members for receiving the Journal free. The Hon. Secretary pointed out the Corporate Members should be included after Ordinary Members for receipt of the Journal on payment of the Journal fee. Both amendments were accepted.

Rule 22. Mrs. Almitra Patel suggested that 1 month's notice be given, which was accepted, but her suggestion that notice of the meeting be advertised in 2 widely read English newspapers was considered unnecessary and expensive, and was not adopted.

Mr. Debi Goenka and Mr. Mulla wanted the Committee's report and the balance sheet to be sent to each member with the notice. The President explained that this would be an expensive procedure and that most people do not bother to read the balance sheet. Any member who asks is provided with copies of these documents, and this practice may be continued. The members agreed to withdraw their proposal.

Rule 23. Messrs. Mulla & Goenka proposed that the first item on the agenda should be approval of the minutes of the previous meeting. After some discussion, this was accepted. The Chairman added that minutes be drafted by the Chairman and circulated to members present within one month. If not objected they would be deemed to be confirmed and finally signed by the Chairman. A formal approval could be taken up at the next A.G.M. Mr. Mulla also suggested that the last item on the agenda be recorded as follows to make the meaning clear. "Such other business as has been submitted in writing at the Society's office, at least a week prior to the meeting, or any other business with the permission of the Chair". This was accepted and it was agreed to redraft the rule to incorporate these suggestions.

Rule 24. The suggestions for a larger number as quorum were considered unpractical and the amendment as drafted was adopted.

Rule 26. The President's suggestion that the original rule of calling an Extra-ordinary General Meeting on a requisition required by 10 members be retained was adopted.

Rule 28. The suggestion by 3 members to delete the provision of residence within 200 or 250 km from Bombay was accepted. The Hon. Treasurer stated that the Executive Committee should frame rules regarding payment, if any, of travel expenses for attending meetings of the Executive Committee and these Rules should be made known to all members.

There was considerable discussion on item (4) of this rule, i.e. inclusion of the Chief Paid Executive of the Society as a member of the Committee, since some members felt that it would be inappropriate to have him as Member of the body which has to decide his own terms of service.

The Hon. Secretary pointed out that the Society has a large scientific component, and the Executive Committee requires inputs on the scientific activities which only the head of of the scientific establishment can provide. He also pointed out that in all scientific research organizations the paid Director is a member of the Governing Council. Mr. Hussain stated that in the RSPB, a membership organization like the BNHS, having its own scientific programmes, the Executive Director, a paid employee, was a member of the Governing Board.

The President opined that this was a question for a referendum. He said he would study the constitutions of various bodies and prepare a draft for a referendum. *Members requested that they be allowed to see the draft before it was finalized, which was agreed.*

Consequence on removal of the residence proviso for membership of the Committee, the suggestion of Mr. Daniel, Mrs. Variava and Mr. Goenka, that Advisory Committee Members should not necessarily be from outside Bombay, but should consist of eminent persons irrespective of their residential address whose opinions would be useful to the Society, was accepted.

Rule 29. The suggestion that voting papers be sent to all members and the words "resident in India" be deleted was suggested by the Hon. Secretary, also stating that this matter was discussed and agreed at an earlier AGM.

The Hon. Treasurer pointed out that airmail postage would be quite heavy and these should not be an additional burden on the Society's finances. The Hon. Secretary pointed out that the foreign members who expressed interest had also stated that they are willing to pay the additional postage cost involved. Further in the recent referendum, some foreign members had replied by cable to ensure that their replies reached us in time. When members take such interest in the affairs of the Society, we should encourage this interest. The matter was put to vote and declared "passed". Consequent on this, the period for return of voting papers was extended from 3 weeks to 4 weeks.

Messrs Mulla and Goenka suggested that there be no panel of names proposed by the Committee, but that nominations be invited and the Committee elected from the persons so nominated. Dr. Nanavati and Dr. Saraiya stated that it should be the responsibility and duty of the outgoing Executive Committee to recommend names of Members who in their opinion would be competent to manage the affairs of the Society. This was particularly the case as our Membership is scattered all over India and also abroad.

It was also pointed out that demanding the members signature on a tear off slip of the voting paper could effect the secrecy of the ballot. The Chairman assured the house that during the recent election the votes were not seen until after the tear off slip had been removed. However, other possibilities would be considered by the Committee.

After some further discussion, the Chairman put the matter to vote, and the proposal of Messrs Mulla and Goenka was declared as carried.

Mr. Goenka's suggestion that the President and Vice Presidents be elected from an elected committee of 16 members was withdrawn at the request of the Chair.

Rule 30. Mr. Goenka's suggestions that vacancies be filled by the person securing the next highest number of votes at the election was considered. Mr. Cyrus Guzder opposed the proposal which sought to take away the right of the Executive Committee to fill such vacancies and he stated this would be wrong in principle. Other members also opposed Mr. Goenka's proposition, which was put to the vote and rejected.

Rule 33. It was felt that a minimum frequency of meetings of the Committee should be laid down. The members agreed that meetings should be held atleast once in 3 months.

Rule 34. Mr. Goenka and Ms. Pandit suggested that the quorum for meetings of the Committee be fixed at 8 and 7 members respectively. After discussion members decided that 6 members should form a quorum.

Rule 35. Ms. Pandit's suggestion of 15 days notice for Committee meetings was not accepted as the practice is to hold the meeting on the 2nd Saturday of a calendar month.

Rule 59. Mr. Mulla's suggestion that the words "in accordance with the Rules" be changed to "1 week before the meeting" to make the matter quite clear, was accepted.

Rule 60. The President drew attention to a typographical error, omission of the word "desirable" at the beginning of the last line. The word was inserted.

Mr. Rane informed the House that Mr. M. D. Agharkar, former member of the Executive Committee, who was mainly responsible for redrafting of the rules, had expired in Pune on 12th March 1988.

The President prepared a condolence resolution as follows:-

> "The Extra-ordinary General Meeting of the Bombay Natural History Society has learned with much sorrow of the sad demise of our M. D. Agharkar, a former member of the Executive Committee and expressed its deepest sympathy and condolences of the bereaved family".

The resolution was passed by members standing in observing two minutes silence.

It was further resolved that a copy of the resolution be sent to the members of the bereaved family.

The meeting terminated with a vote of thanks to the Chair.

APPEAL

DATA WANTED

We are writing a review on plant phenology (leaf, flower, fruit, and seed/germination). We know that many researchers have collected phenological data as background information for studies with other objectives. We are trying to review phenological patterns on a global scale, and in many ecosystems there are few published accounts. If you have data you would be willing to contribute on phenology we would be interested in hearing from you. All contributions will be properly acknowledged in the review. We would greatly appreciate a detailed description of the methods used in collection of these data. We would also appreciate reprints and manuscripts in press or in review.

T. Mitchell Aide 801 581 7086
Todd Dawson 801 581 5927
Department of Biology
University of Utah
Salt Lake City, UT 84112
USA

ERRATA

VOLUME 85(2) : AUGUST 1988

BIOLOGICAL NOTES ON TWO SPECIES OF BIG-EYED BUGS (INSECTA: HEMIPTERA: LYGAEIDAE: GEOCORINAE)

On page 302, in Table 3,

For *G. bengalensis* Read *G. pseudolituratus*

For G. *pseudolituratus* Read *G. bengalensis*

Miscellaneous Notes

18. MOVEMENT OF THE EASTERN SWALLOW (*HIRUNDO RUSTICA GUTTURALIS*) RINGED AT MOOTPUZHA (KERALA)

On page 429,

Left column, line 6-7,

For Moovatpuzha *Read* Mootpuzha

Right column, line 14,

For two recoveries from three locations

Read three recoveries from three locations

BOMBAY NATURAL HISTORY SOCIETY

Hundred and fourth Annual Report & Accounts, 1987

Patron
Mr Rajiv Gandhi
Prime Minister of India

President
Mr Justice M Hidayatullah

Vice Presidents
Prof. P V Bole
Mr Humayun Abdulali

Hon. Secretary
Dr A.N.D Nanavati

Hon. Treasurer
Dr Pratap R. Saraiya

Executive Committee

Mr M.R. Almeida
Dr Erach K. Bharucha
Mr Cyrus J Guzder
Dr B.F Chhapgar
Dr (Ms) Meena Haribal
Mr Kisan Mehta
Mr Ulhas Rane
Mr Digveerendrasinhji Solanki
Prof. Parvish K. Pandya
Mrs. D.S Variava
The Secretary (Ex-officio)
Dept. of Education & Welfare,
Govt. of Maharashtra, Bombay

Auditors

M/S HABIB & COMPANY CHARTERED ACCOUNTANTS, BOMBAY

Registered Office

HORNBILL HOUSE
SHAHEED BHAGAT SINGH ROAD
BOMBAY 400 023

Honorary Secretary's Report for The Year 1987

104TH ANNUAL REPORT

DR. SALIM ALI

The year 1987 started on a gloomy note for the Society. The health of Dr Salim Ali, the Society's President, who had been the main stay of the Society since the early days of independence, deteriorated. Inspite of his frail condition and failing stamina, Dr. Salim Ali, from his sick bed kept himself in touch with the Society's affairs, sharing his valuable experiences in procedural matters and in the operation of the field projects. It is with great regret we record his death which occurred on the 20th of June 1987.

	1983	1984	1985	1986	1987
Ordinary Members	1553	1762	1764	1680	1960
Corporate Members	158	132	152	138	81
Life Members	484	562	639	737	986
Compound Corporate Members	102	107	108	115	115
Student Members	182	192	164	141	190
Honorary Members	3	3	3	3	3
Vice Patrons	4	6	6	6	6
Centenary Life Members	3	3	3	3	3

Members elected in 1987, but not paid 17
Members paid for 1986 but not paid for 1987 318

Membership:

The revised membership fee did not have any particular impact on the statistics of membership. The data on the past five years membership indicates a marginal increase in Life and Ordinary membership. However, there was considerable fall in Corporate membership. The compound corporate membership remained static as this class of membership has been discontinued. There is however considerable scope for improving the membership strength of the Society and special efforts are being planned.

MEMBERS ACTIVITIES

Members field activities have considerably increased with the enthusiastic and sustained support of members, particularly in Bombay.

Bus outings/overnight nature camps: The bus donated by Telco (Tata Electric Locomotive Company) has been of considerable help in organising weekend outings and overnight camps at various places of natural history interest. The following overnight nature camps were held during the year.

Overnight Nature Camps :	*Location*	*Group Leader*
1. 25th-26th January	Kalsubai	S. R. Shah
2. 21st Feb. to 1st March	Nandur-Madmeshwar, Nasik	Ulhas Rane V. Thakkar
3. 21st-22nd March	Matheran	Ulhas Rane
4. 28th-30th March	Karnala	
5. 17th-19th April	Shivthar in Sahyadris near Mahad, dist. Raigad	Ulhas Rane
6. 30th April to 3rd May	Castle Rock	Ulhas Rane
7. 30th July to 2nd August	Battis Shirala and Kaslake	Ulhas Rane
8. 28th-30th August	Marleshwar in Ratnagiri	Ulhas Rane
9. 26th-27th Sept.	Suryamal - Shahpur	Ulhas Rane
10. 2nd-4th Ocober	Pal Yawal	Ulhas Rane
11. 10th-11th October	Sagargad	V. K. Paralkar
12. 12th-13th December	Lonavala to Koregad along with Save Sahyadri	Manek Mistry
13. 25th-27th December	Nandur Madmeshwar	Oswald Thayil/Datta Ugonkar

Annual Nature Camps: The frequency of Annual Nature Camps has increased from 1 or 2 per year to 4 in 1987. The response for these camps from members was good.

Dodital Nature Camp: A camp was organised for two batches each of 20 persons at Dodital, a spring fed lake at a height of 3042 metres in Garhwal Himalayas — Group Leader Dr. (Ms.) Meena Haribal.

Bhimashankar Sanctuary 31st October to 8th November. A trekking programme was organised. Bhimashankar is a sacred grove around a famous Shiv temple situated at the crest of the Sahyadri mountain range in Ambegaon Taluka of Pune. The Evergreen Forest at the top and moist-deciduous forest on the slopes support excellent wildlife. — Group Leader — Ulhas Rane.

Saputara/Dang Forest, Gujarat — 27th October: Situated at an altitude of 872.9 m, it is the second highest plateau of the Sahyadri Range in the heart of the Dangs Forests. — Group Leader — Ashok Kothari.

Sanctuaries of the Western Ghats: A bus trip was organised and members in two batches visited Radhanagri, Molem, Dandeli, Nagarhole, Bandipur, Mudumalai, Mukruti, Topslip and Parambikulam.

The first batch went by BNHS bus upto Parambikulam and returned to Bombay by rail. The second batch joined at Parambikulam and toured in the reverse direction — Group Leaders: P. B. Shekar/M. R. Almeida, Vasant Naik.

Day outings: Nature walks in the forest and along the sea shore and birdwatching programmes were popular among members. Bird count programmes continued to attract serious birdwatchers and amateur members. The following trips were arranged during the year.

Nature Walk:

1. Madh to Gorai Sea Shore — 11th January — Ulhas Rane
2. 1st February — Ransailake in Raigad Dist. — Ulhas Rane/P. B. Shekar
3. 8th February — Thane to Kanheri caves via Yewoor — C. B. Mehta
4. 22nd February — Nagla trail beyond Chena Creek — M. R. Almeida/ C. B. Mehta
5. 8th March — Borivli National Park
6. 26th April — Kanheri Caves to Aarey Goregaon through Borivli National Park
7. 1st May — Borivli National Park — J. S. Serrao
8. 12th May — Film City to Vihar Lake (at night) — S. R. Shah
9. 7th June — Yewoor road to Ashokvan (Borivli National Park) — S. R. Shah
10. 14th June — Nagothane to Pali — Ulhas Rane
11. 5th July — Bhoot Bangla, Borivli National Park — C. B. Mehta
12. 12th July — BNHS Land, Goregaon
13. 2nd August — Nature Walk at Pongam Valley — C. B. Mehta
14. 16th August — Kondgaon Lake in Raigad district — S. R. Shah
15. 23rd August — Nature Walk at Karnala — P. Pandya
16. 6th September — Lohgad Fort/Lonavala — Ulhas Rane
17. 20th September — Monsoon Flora, Borivli National Park — P. V. Bole/M. R. Almeida
18. 1st November — Borivli National Park, Bhoot Bangla — C. B. Mehta
19. 22nd November — Gorai Beach — B. F. Chhapgar

Bird Count outings at S. G. National Park, Borivli:

18th January, 15th February, 15th March, 5th April, 17th May, 21st June, 19th July, 9th August, 13th September, 18th October, 15th November and 6th December.

Special programmes were organised to commemorate the birth anniversary of the Late Dr. Salim Ali. An exhibition of Birds on postage stamps was organised at Hornbill House and was inaugurated by Mr. S. P. Godrej, the stamp collections of Mr. D. R. Mistry and Mr. Farukh Shah, Mr. N. Chaturvedi, Mr. Siraj Taher, Mr. Cyrus Sidhwa and Maj. Gen. D'Souza were displayed. An oil painting of Dr. Salim Ali presented by Mr. J. P. Irani was unveiled.

As a part of this programme a Nature trail was inaugurated on the BNHS land at Goregaon adjoining the Sanjay Gandhi National Park by the Director of the Park.

A painting competition for school children was also organised jointly with the Save Western Ghats movements.

Several slide and filmshows were organised during the year.

Members' Field Research Studies:

Dr Narendra Prasad studied the Krishna estuary mangrove habitats. His report was helpful in the conversion of this area into a sanctuary. The study was funded by the SANCF.

A rapid survey of the Dugong habits in the Gulf of Mannar was conducted by Dr. Helen Marsh and S. A. Hussain with financial assistance from the SANCF.

Journal:

During the year Vol. 83(3) and A Centenary Supplement (1886-1986) commemorating the Centenary of the Journal and Vol. 84 (1) the first issue for April 1987 were published. The 764 pages of these Journals held 164 articles and notes. During the year 320 articles and notes were received from members and others.

SALES STATEMENT

	Stock 31.12.86	Sales in		Com. copy	Balance Stock 31.12.1987
		1986	1987		
The Book of Indian Birds	4772	1545	1412	2	3358
The Book of Indian Animals	1866	412	859	1	1006
Some Beautiful Indian Trees	821	273	219	–	602
Checklist of the Birds of Maharashtra (2nd Edition)		101	97		
Checklist of the Birds of Delhi, Agra and Bharatpur		81	80		
A Synopsis of the Birds of India and Pakistan	1428	55	35	–	1393
Grasses of Western India	156	59	26	–	130
Some Beautiful Indian Climbers and Shrubs	1875	186	119	–	1756
A Pictorial guide to the Birds of the Indian Sub-continent	1821	1664	107	–	1714
A Century of Natural History	2110	108	58	1	2051
The Book of Indian Reptiles	3405	408	316	–	3089
Encyclopedia of Indian Natural History	400		326	26	48

Hornbill:

Four issues of the *Hornbill* were published during the year. The *Hornbill* continued to be popular with the members. However, it can be more effective as a conservation and popular nature education medium only with the cooperation of members in the form of articles

By an Agreement dated 23rd July 1987, the Oxford University Press were appointed Co-Publishers and they commenced the marketing of BNHS books towards the end of the year.

UNIVERSITY DEPARTMENT

A thesis was submitted during 1987 by Mr. H. B. Naithani in botany on bamboos of eastern India under the guidance of Mr. M. R. Almeida. We have the following students registered for M.Sc. and Ph.D.

	M.SC. ZOOLOGY	
Mr. Shahid Ali	Ecology and behaviour of the Grey Partridge *Francolinus pondicerianus*	Mr. J. C. Daniel
Mr. Alagar Rajan	Ecology of Spotted and Ring Doves	Dr. Robert B. Grubh
Mr. Vibhu Prakash	Biology of Raptors	Dr. V. S. Vijayan
Mr. Gurmeet Singh	Ecology of Bank Myna	Dr. R. B. Grubh
Mr. Ramachandran	Ecology of the Jacanas	Dr. V. S. Vijayan
Mr. Ravi Sankaran	The Ecology of the Lesser Florican	Mr. J. C. Daniel
	PH.D. ZOOLOGY	
Mr. U. Sridharan	Ecology of Resident Ducks in Keoladeo National Park	Mr. J. C. Daniel
Mr. Goutam Narayan	The Ecology of the Bengal Florican	Mr. J. C. Daniel
Mr. S. M. Satheesan	Birds of Prey	Mr. J. C. Daniel
Mr. Sunderamoorthy	The Ecology of terrestrial Birds of Keoladeo National Park, Bharatpur	Mr. J. C. Daniel
Mr. Natarajan	Ecology of Crow-Pheasants	Mr. J. C. Daniel
	PH.D. BOTANY	
Mr. Manek Mistry	Contributions to the flora of Ratnagiri dist. in Maharashtra	Prof. P. V. Bole
Mr. Balakrishnan	Bird Plant interaction	Prof. P. V. Bole

NATURE EDUCATION SCHEME

The Nature Education Sub-Committee carried out the educational activities at different levels for different target groups. The Nature Education Organiser concentrated her activities for the students and teachers of the schools and colleges from Bombay. The Committee members carried out various educational programmes for the B.N.H.S. members, college students and also for the people in the rural areas.

At the beginning of the Academic year 500 schools in Bombay and Thane were contacted through a circular letter on our Nature Education Activities.

Approximately 8000 students took advantage of the N.E. Activities. Besides students 200 teachers and 250 trainee teachers also participated in our environmental education activities for teachers. A nature camp for Municipal school children was also held.

Nature Camp at Radhanagari:

A nature camp for underprevileged school students was held at Radhanagari Sanctuary, Kolhapur from 4th November to 8th November 1987. 35 students from Marathi, Gujarati, Hindi and Urdu medium were selected for the camp on the basis of an essay competition. Four teachers accompanied the students.

Quiz programme for Jr. Colleges and Schools:

As a part of the World Forestry Day Celebrations a quiz on Wildlife was organised for the students of 11th and 12th STD. (Jr. College) and 8th to 9th STD (school level). 10 Jr. Colleges and 25 schools participated.

Field Programmes:

Forty two field trips were conducted during the year. Among these 35 were to Borivli National Park, 2 to Karnala and 2 to Lonavala and 3 to Tansa. Among these field trips, 3 were for Jr. Colleges and 4 for trainee teachers. 1600 students from VIII to XII STD and 180 trainee teachers participated in these field programmes.

Teaching through exhibits:

During the year 10 visits to the Prince of Wales Museum, 4 visits to Victoria Garden and 7 visits to the Aquarium were arranged. These visits were mainly for the students of VI to VIII STD.

10 new schools were enrolled by the N.E.O. for nature education activities.

A wildlife exhibition was arranged during Akashwani Vidnyan Sammelan from 26 to 28 January, organised by the All India Radio at Wada College in Thane district. About 20000 students and villagers attended the exhibition.

The committee members organised a Nature Orientation Camp for selected B.N.H.S. members at the I.I.T. Bombay from 27th June to 1st July, to train the volunteers for the educational activities. A Conservation Education Camp for school children and teachers in the rural areas of Niphad taluka, Nasik district was arranged from 25th to 27th January at Nandur-Madmeshwar with the help of members from Niphad.

The birth anniversary of Dr. Salim Ali was celebrated on the 12th November by inaugurating a self guided Nature Trail on the B.N.H.S. land near Borivli National Park. The brochure giving brief natural history information was published on the occasion. A visual exhibition 'Save Sahyadri' was prepared with financial assistance from the Salim Ali Nature Conservation Fund. This was used in the rural areas of Maharashtra during the Save Sahyadri March from 1st November 1987 to 5th February 1988. Simultaneously, nature education programmes were arranged at various villages during the March, with the help of members.

PROJECTS

Hydrobiology (Ecological Research Station), Bharatpur

The work during the year was a continuation of the previous year's work. A survey of the status of turtles along with their aestivation habits inside the park, association of aquatic macrophytes with the aquatic macroinvertebrates and an intensive study on the terrestrial bird communities were new projects launched during the year. A project was taken up in collaboration with the French Institute, Pondicherry to prepare a vegetation map of the park. The possible adverse ecological impacts of the proposed galvalume plant near the park was assessed. Most of the laboratory facilities for this work were offered by Dr. P. P. Bakre and Dr. Rai of the Rajasthan University.

The research staff remained the same as in 1986. Although many vacancies existed, these could not be filled owing to financial constraints. However, the members of the team cooperated well and worked hard with a sense of commitment to maintain continuity of data.

STUDIES ON THE MOVEMENT AND POPULATIONS STRUCTURE OF INDIAN AVIFAUNA

Field Work: In June 1987 the Point Calimere field station completed 7 years field work.

Data collection was carried out on the following main subjects.

Bird ringing: Birds trapped were ringed, aged and examined for moult.

Weather data: Max-Min. temperature, Rainfall and Humidity were recorded.

Insects: Population fluctuations in the study areas were studied.

Bird census: Census of landbirds as well as waterbirds were carried out on alternate working days along two fixed census paths. A one km long census path was selected in the forest as well as in the swamp for censusing landbirds and waterbirds.

Apart from the regular field work the research staff visited Institutions and Colleges and carried out identification and reference work.

Endangered Species Project

The project on the great Indian bustard ended in 1987. A report on our studies at Rollapadu Bustard Sanctuary, Andhra Pradesh was brought out in 1987. Recommendations for the conservation of bustards in Andhra Pradesh were given.

A small report on the conservation and management of an excellent waterbody called Dihaila Jheel, located in the Karera Bustard Sanctuary, Madhya Pradesh, was also printed and widely distributed. The Government of Madhya Pradesh has followed up our recommendations and Dihaila jheel is now on a high priority of the M.P. Forest Department to be made as a bird sanctuary.

The second annual report on the florican project which is an annexure of the Endangered Species Project, was brought out. Status survey of the lesser florican could not be done due to severe drought in Gujarat which is the main breeding area of this species. Studies on the Bengal florican were started in Manas in Assam and Dudwa in U.P. Results of these studies will be given in the third annual report.

Bombay, 8th October, 1988.

The Study of Some Endangered Species of Wildlife and their Habitats:

Mudumalai was taken up as an intensive study site as it was representative of the entire area (Nagarhole-Bandipur-Mudumalai-Wynnad) which supports a large elephant population in a contiguous terrain. It was also ideally suited to study cattle and human pressure on the elephant habitat. The large number of elephants which use the reserve, revenue and private forests adjoining this sanctuary, are also in danger of being pushed back into the sanctuary if these forests are lost or degraded in future. The collection of data on demographic parameters and some vegetation studies were also done in the other areas. In Mudumalai, information was collected on a) Population dynamics, b) Social behaviour, c) Feeding ecology, d) Vegetation studies, e) Carrying capacity and f) Movement pattern and home range.

To achieve these objectives, data was collected by three field biologists based at Mudumalai.

Field data was collected on population dynamics, social behaviour, movement pattern and home range of elephants by Mr. A. A. Desai. Mr. N. Sivaganesan collected data on feeding ecology. vegetation studies and carrying capacity. He was assisted in his work by Mr. S. Rameshkumar, who after his initial training, collected data mainly on vegetation and carrying capacity. He also assisted in collecting data on captive elephants.

Mr. Sivaganesan has completed data collection and will be analysing the entire data collected on feeding ecology, vegetation studies and carrying capacity. This will be presented in a separate report giving the findings.

Considerable data has been collected; for others more data is needed. For long-lived animals such as elephants short term studies do not provide adequate information and can be misleading.

Honorary Treasurer's Report for The Year 1987

1. During the year, the aggregate of the Society's Capital, Funds and Reserves increased by 17% to Rs. 55.60 lakhs. There was also a large increase in advances received, mainly Grants for the USFWS Projects, and the total 'Liabilities' rose from Rs. 80 lakhs (1986) to Rs. 1.30 crores.

2. The set-up of Fund Accounts has been reorganised in order to optimise income by way of interest and also utilisation of resources. In the process, some Accounts have been closed by transfers. In 1987, a total of approx. Rs. 30 lakhs was invested in units of the U.T.I. and fixed deposits. The aggregate of balances in the Saving Bank Accounts also went up from Rs. 6 lakhs (1986) to Rs. 45 lakhs. As a result, income from interest will go up in the current year.

3. Coming to the Revenue/Expenditure Account, a welcome feature is the receipt of Maharashtra Govt. Grant for 1986/87; the Grant for 1987/88 is expected shortly. Another feature is the increase of 43% in the surplus from the sale of nature calendars and greeting cards. With regard to the sale of books, our arrangement with the Oxford Univ. Press commenced in October 1987, and that is not reflected in the Accounts. However, we expect a considerable increase in the income from this activity in the current year. After making the usual appropriations, etc., the year shows a surplus of Rs. 18,319 as compared to a deficit of Rs. 1.38 lakhs in the previous year.

4. However, the Society's financial position cannot be considered satisfactory. The current year has seen a substantial increase in the activities in regard to the major scientific Projects, for which the Society is required to provide the necessary administrative back-up. There is also a pressing need to improve and extend the Society's traditional activities. Unfortunately, establishment and other costs are going up steeply due to inflation, and the Society urgently requires additional financial resources. It is hoped that the Salim Ali Memorial Fund can be built up to a magnitude that would enable the Society to meet these challenges.

5. Pursuant to The Direct Tax Laws (Amendment) Act, 1987, the Society's Accounting year will henceforth end on 31 March, and the current year will be extended to cover a period of 15 months, viz. from 1 January 1988 to 31 March, 1989.

PRATAP R. SARAIYA
Honorary Treasurer

BOMBAY, 28th September, 1988.

AUDITORS' REPORT

Re: Bombay Natural History Society

Regn. No. F-244 (BOM)

We have audited the attached Balance Sheet of the Society as at 31st December 1987 and also annexed Income & Expenditure Account ended on that date and report that in our opinion and to the best of our information and explanation given to us:

a) the accounts are maintained regularly and in accordance with the provisions of the Bombay Public Trust Act, 1950, subject to the observation that as per the past practice separate Receipt & Payment Account has been drawn for the Nature Education Scheme, and the same has not been incorporated in the accounts of the Society. We also observe that during the year the Society did not receive the annual grant for the year 1987-88 towards Establishment and Building Maintenance and for the publication of the Journal (Educational activity) and no sanction letters too having been received the same have not been brought into account. The relevant expenses have therefore been charged to Income and Expenditure account,

b) the receipts and disbursements have been properly and correctly shown in the accounts,

c) the cash balance and the vouchers in the custody of the accountant on the date of audit were in agreement with the books of accounts,

d) the books, deeds, accounts, vouchers and/or other documents or records required by us were produced to us,

e) The register of movable and immovable properties is properly maintained but the changes therein have not been communicated to the Regional Office for items other than additions to dead stock. In respect of change report for the dead stock stated to have been filed with the Regional Office, the relevant acknowledgement was not available.

f) the accountant appeared before us and furnished the necessary information required by us,

g) we are not aware of any property or funds of the Society having been applied for any objects or purposes other than the objects of the Society,

h) the following items were outstanding for more than one year:

i)	Dues towards Supplies & Services	Rs. 13,441.99
ii)	Income-tax recoverable	Rs. 2,075.00

A sum of Rs. 30,388/- has been written off as irrecoverable dues during the year which inter alia includes Rs. 28,860.15 representing amount defaulcated by one of the employees during the year 1984 at Bharatpur Research Station as reported in our report dated 7th Jan., 1986 accompanying the statement of account for the year ended 31st December 1984. We may add that the outstanding against Supplies and Services interalia include certain items which are outstanding since 1985. We have been assured that the outstanding balances are considered good and realisable. We may nonetheless suggest that effective measures be taken to realise the outstanding.

i) The expenditure on repairs and maintenance of property in the occupation of the Society incurred during the year includes expenditure of Rs. 27,158/- on repairs which has been carried out through contractors. We are informed that quotations were invited for the repair work involved and the same was entrusted to one of the contractors as per the sanction of the Executive Committee.

j) We are not aware of any money of the Society having been invested in contravention of Section 35 of the Bombay Public Trust Act, 1950,

k) we are not aware of any immovable property of the Society, therefore, the question of alienation of any immovable property contrary to the provisions of Section 36 of the Bombay Public Trust Act 1950 does not arise,

l) i) in regard to the expenses charged to various grants and funds, we have relied on the information given to us and the authentication of the Honorary Secretary and Honorary Treasurer that the expenses so charged relate to these grants and have been spent on the specific objects for which the grants were received. While checking the statement of accounts in regard to the expenditure incurred at various camps, we have relied on the authorisation by the Honorary Secretary and Honorary Treasurer as to the reasonableness of the expenditure,

ii) the income towards membership subscription is being accounted on realisation basis,

iii) the subscriptions received in foreign currency, we observe, are deposited in an account maintained with Grindlays Bank Plc, London Branch. The said receipts and disbursement made therefrom have been accounted at the exchange rate prevailing at the date of the Balance Sheet. The closing balance has been translated at the current exchange rate, at the date of the balance sheet and the difference in exchange amounting to Rs. 11,400.78 has been credited to Income and Expenditure account.

iv) we suggest the following items of disbursement effected, provisions made, administration charges levied and amount written off be confirmed and ratified at the next meeting of the Executive Committee:

A)	*Disbursement from:*	Rs.
i)	Interest on Col. Burton's Nature Conservation Fund	22.50
ii)	Chas McCann Vertebrate Zoology Field Work Fund	1,210.75
iii)	Interest on Salim Ali/Loke Wan Tho Ornithology Research Fund Investment	14,548.00
iv)	Interest on Salim Ali Nature Conservation Fund Investment	37,485.80
v)	Interest on Pirojsha Godrej Foundation Field Work Fund Investment	4,241.37
vi)	Dorabjee Tata Trust Field Work Fund	1,850.80
vii)	Plant Study Fund	1,872.46
viii)	Field Study & Scholarship Fund from Watanmal Boolchand Charitable Trust	3,952.05
ix)	Mini Bus Maintenance Fund (Created from Income)	6,776.90
x)	Library Fund (created from Income)	3,479.00
xi)	Darbar Alkachar Charitable Trust for Seminar expenses	5,000.00

xii)	Grant Govt. of Maharashtra for 1986-87 towards Establishment, Building Maintenance & Educational Activity (i.e. Journal Printing expenses)	1,84,552.00
xiii)	Govt. of India, ARDB Grant for ecological study of Bird Hazard at Indian Aerodromes	3,51,421.23
xiv)	Govt. of India, ARDB Grant for Bird Hazard Research Cell	37,675.25
xv)	Govt. of India, ARDB Grant for ecological relevance of Whitebacked Vulture	9,791.95
xvi)	Grant from U.S. Department of Interior, Fish & Wildlife Service for:	
	a) Studies on the Movement & Population Structure of Indian Avifauna	3,51,656.32
	b) Hydrobiological (Ecological) Research Station at Keoladeo Ghana Sanctuary, Bharatpur	3,00,788.13
	c) Study of ecology of certain endangered species of Wildlife and their habitat	2,54,894.60
	d) Study of Lesser Bustard (Florican)	4,40,689.25
	e) Ecology of Keoladeo National Park, Bharatpur	5,11,589.46
	f) Ecology of Pt. Calimere Sanctuary	44,092.73
	g) Ecology of Indian Elephants	1,01,796.89
	h) Study of Migration Pattern of Indian Birds & Avifauna Migration Data Bank	88,067.75
xvii)	Grant from Chief Wildlife Warden, Chandigarh for Bird Ringing Project at Harike	55,027.36
xviii)	Grant from Chief Wildlife Warden, Bhubaneshwar, for Bird Ringing Project at Chilka	2,689.97
xix)	Grant Govt. of India (D.O.E.) for the expenses on secretarial assistance to Dr Salim Ali for environmental research for processing archival material	12,497.00
xx)	Grant Govt. of India (D.S.T.) for the publication of Centenary Supplementary Issue	50,000.00
xxi)	Grant Indian National Science Academy for the publication of Journal	5,000.00
xxii)	Grant Chief Wildlife Warden, Jammu & Kashmir for the project on survey of Black-necked Crane	38,735.16

B) *Appropriations*:

Govt. publication fund, sale proceeds of publications	14,240.81
Surplus income from Greeting Cards sales to Research & Scholarship Fund	3,22,796.80
Mrs Indira Gandhi Paryavaran Award to Dr Salim Ali Memorial Fund	1,00,000.00
Fixed Assets Funds towards depreciation on fixed assets	34,479.35
Amounts written off	30,388.05
Administrative fees charged to various grants/funds for handling project, etc.	3,50,832.29
Addition to fixed assets (other than those directly charged to various projects)	15,567.50

m) So far, as it is ascertainable from the books of accounts and according to the information and explanation furnished to us by the accountant and the Hon. Secretary, there were no cases of irregular, illegal, or improper expenditure or failure to recover the monies or other properties belonging to the Society or of loss or waste of money or other property of the Society, subject to the observations made in para (h) hereinabove.

n) Provision of Section 31-A and Rule 16-A of Bombay Public Trust Act 1950 have not been complied with.

II. a) The maximum and minimum number of trustees is maintained having regard to the provisions contained in the rules and regulations,

b) there is no specific provisions in the rules & regulations of the Society regarding the holding of the meetings is maintained.

c) the minute book recording the proceedings of the meetings is maintained,

d) no member of the Managing Committee has any interest in the investment of the Society,

e) no member of the Managing Committee is a debtor or a creditor of the Society.

Bombay:

Dated: 16 Sept. 1988

HABIB & CO.
CHARTERED ACCOUNTANTS
PATHARIA PALACE,
75, MOHAMEDALI ROAD,
BOMBAY - 3.

Regd. No. F-244 (BOM)

THE BOMBAY PUBLIC TRUSTS ACT 1950

SCHEDULE VIII VIDE RULE 17(1)

THE BOMBAY NATURAL HISTORY SOCIETY, BOMBAY 400 023.

BALANCE SHEET AS AT 31ST DECEMBER 1987

FUNDS AND LIABILITIES		
Trusts Funds or Corpus:		
Life Membership Fund (Individual):		
Balance as per last Balance Sheet	5,57,404.27	
Add: Amount received during the year	2,32,045.59	7,89,449.86
Corporate Life Membership Fund:		
Balance as per last Balance Sheet		2,15,742.31
Vice Patron Fees:		
Balance as per last Balance Sheet		42,769.00
Corpus Funds:		
As per Schedule "A"		10,92,691.48
Other Funds:		
As per Schedule "B"		34,18,918.72
Liabilities:		
Unspent Grants as per Schedule "C"	66,11,577.17	
For Expenses	4,40,876.82	
For Library Deposits	1,700.00	
For Sundry Credit balances	1,38,157.16	
For Advance Publication	68,375.47	72,60,686.62
Carried over		1,28,20,257.99

ASSETS		
Immovable Properties:		
Investments (at appropriate value):		
Government Securities (At cost): 5.5% Govt. of India Loan 2,000 of the face value of Rs. 2,000/- (Market value Rs. 1,211.00)	2,000.00	
3739.287 Units of the Unit Trust of India under reinvestment plan of the face value of Rs. 100/- each. (Total face value Rs. 3,73,928.70 including accumulated dividend units 1739.29)	3,81,525.79	
70150 Units of Unit Trust of India each of the face value of Rs. 100/- (Total face value Rs. 7,01,500/-). Unit Scheme 1964	9,99,637.50	
Fixed Deposits with:		
i) M/s. Bharat Petroleum Corpn.	5,00,000.00	
ii) Housing Development Finance Corporation Ltd.	10,00,000.00	
iii) Housing Development Finance Corporation Ltd.	10,00,000.00	38,83,163.29
Carried over		38,83,163.29

FUNDS AND LIABILITIES		
Brought over		1,28,20,257.99
Other Advances:		
Amount received for and on behalf of the proposed Institute.		
Balance as per last Balance Sheet	2,56,533.96	
Add: Interest credited during the year	20,000.00	
	2,76,533.96	
Less: Expenditure for and on account of the institute incurred during the year	15,555.05	2,60,978.91
Carried over		1,30,81,236.90

ASSETS		
Brought over		38,83,163.29
Motor Cars, Motor Cycle, Auto Cycle and Mini Bus:		
Balance as per last Balance Sheet	1,04,786.32	
Less: Depreciation during the year	20,957.25	83,829.07
Furniture, Fixture and Equipment:		
Balance as per last Balance Sheet	92,609.36	
Add: Addition during the year	15,567.50	
	1,08,176.86	
Less: Depreciation during the year	13,522.10	94,654.76
Loans (Unsecured considered good):		
To employees		21,750.00
Advances (Unsecured considered good):		
To Trustees	—	
To Employees for project expenses	1,68,756.07	
To Employees for the Society's expenses	8,581.90	
To others	30,228.85	
To Nature Education Scheme	27,855.62	2,35,422.44
Carried over		43,18,819.56

FUNDS AND LIABILITIES		ASSETS		
Brought over	1,30,81,236.90	Brought over		43,18,819.56
		Stock:		
		A) Publication under BNHS Funds as per inventory taken and certified by Hon. Secretary at or below cost	5,43,229.57	
		B) Publication under Govt. Funds as per inventory taken and certified by Hon. Secretary at or below cost	1,13,339.94	
		C) Safety Cartridges (as certified by the Honorary Secretary)	9,530.35	
		D) Publications (under preparation) Expenses incurred till date		
		i) Book of Indian Trees	7,126.90	
		ii) Book on Encyclopedia of Indian Natural History	41,407.10	7,14,633.86
		Income Outstanding:		
		Interest accrued	67,599.46	
		Supplies and Services (Bills receivable)	5,13,645.34	
Carried over	1,30,81,236.90	Carried over	5,81,244.80	50,33,453.42

FUNDS AND LIABILITIES		ASSETS		
Brought over	1,30,81,236.90	Brought over		50,33,453.42
		Income outstanding (Contd...):	5,81,244.80	
		Grant Govt. of Maharashtra for Establishment, Bldg. Maintenance, Educational Activity (Journal Printing) and Nature Study Teaching Scheme for 1986-87	2,13,266.00	
		Grant Indian National Science Academy for 1987-88	5,000.00	
		Sundry Debtors for Grants ARDB	2,43,714.00	10,43,224.80
		Income Tax Refundable:		3,905.00
		Cash and Bank Balance:		
		As per Schedule 'D' including Rs. 18,49,583.34 in Fixed Deposits		68,84,620.48
		Income & Expenditure account Balance as per last Balance Sheet	1,34,352.82	
		Less: Excess of Income over expenditure as per Income & Expenditure A/c.	18,319.62	1,16,033.20
Total	1,30,81,236.90	Total		1,30,81,236.90

Honorary Treasurer,
Bombay Natural History Society
TRUSTEE

Honorary Secretary,
Bombay Natural History Society

As per our report of even date
Habib & Co.,
Chartered Accountants

Bombay, 16*th September* 1988.

SCHEDULE 'A'

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST DECEMBER 1987

No.	*Name of the Corpus Funds*	*Balance as per last Balance sheet* 1	*Amount recd/ appropriated during the year* 2	*Transferred from other funds during the year* 3	*Total of columns 1, 2 & 3* 4	*Transferred to other funds during the year* 5	*Balance as on 31-12-87 (4 minus 5)* 6
1.	Sálim Ali/Loke Wan Tho Ornithological Research Fund	3,73,136.52	—	—	3,73,136.52	—	3,73,136.52
2.	Sálim Ali Nature Conservation Fund for Silent Valley Campaign	11,341.97	—	—	11,341.97	11,341.97	—
3.	Sálim Ali Nature Conservation Fund	6,65,212.99	—	11,341.97	6,76,554.96	—	6,76,554.96
4.	Col. Burton's Nature Conservation Fund	3,000.00	—	—	3,000.00	—	3,000.00
5.	Pirojsha Godrej Foundation Field Work Fund	40,000.00	—	—	40,000.00	—	40,000.00
	Total	10,92,691.48	—	11,341.97	11,04,033.45	11,341.97	10,92,691.48

SCHEDULE 'B'

BOMBAY NATURAL HISTORY SOCIETY
SCHEDULE FORMING PART OF BALANCE SHEET AS ON 31ST DECEMBER 1987

No.	Name of the other Funds	Balance as per last Balance sheet 1	Amount recd./ appropriated during the year 2	Interest credited during the year 3	Total of columns 1 2 3 4	Expenditure on objects of the Society as shown in the Income & Expenditure A/c 5	Transferred to other funds during the year 6	Balance as on 31-12-87 7
1.	Staff Welfare Fund	35,822.84	500.00	—	36,322.84	—	—	36,322.84
2.	Interest on Col. Burton's Nature Conservation Fund Investment	332.83	—	300.00	632.83	22.50	—	610.33
3.	Charles McCann Vertebrate Zoology Fund	63,502.28	1,895.52	6,350.22	71,748.02	1,210.75	—	70,537.27
4.	Hospitality Fund from Dr Salim Ali	29.87	—	—	29.87	—	29.87	—
5.	Projector Fund received from Members	252.24	—	—	252.24	—	252.24	—
6.	Interest on Salim Ali/ Loke Wan Tho Ornithological Research Fund Investment	58,341.12	—	37,313.65	95,654.77	14,548.00	—	81,106.77
7.	Interest on Salim Ali Nature Conservation Fund Investment	1,79,411.14	—	66,521.29	2,45,932.43	37,485.80	—	2,08,446.63
8.	Interest on Field Work Fund under Pirojsha Godrej Foundation Fund Investment	5,984.32	—	4,000.00	9,984.32	4,241.37	—	5,742.95
9.	Field Work Fund — Sir Dorabjee Tata Trust	10,000.00	—	—	10,000.00	1,850.80	—	8,149.20
10.	Field Study and Scholarship Fund from Watanmal Boolchand Charitable Trust	11,517.90	—	—	11,517.90	3,952.05	—	7,565.85
11.	Photography Exhibition Fund received from Sri M Y Ghorpade of Sandur	10,000.00	—	—	10,000.00	—	—	10,000.00
	Carried over	3,75,194.54	2,395.52	1,14,485.16	4,92,075.22	63,311.27	282.11	4,28,481.84

No.	Name of the other Funds		Balance as per last Balance sheet 1	Amount recd./ appropriated during the year 2	Interest credited during the year 3	Total of columns 1 2 3 4	Expenditure on objects of the Society as shown in the Income & Expenditure A/c 5	Transferred to other funds during the year 6	Balance as on 31-12-87 7
	Brought over		3,75,194.54	2,395.52	1,14,485.16	4,92,075.22	63,311.27	282.11	4,28,481.84
12.	Plant Study Fund	91,739.24							
	Add: Unspent interest on Plant Study Fund Investment as per last balance sheet	4,501.05	96,240.29	20.00	9,173.92	1,05,434.21	1,872.46	9,602.50	93,959.25
13.	Education & Research Fund (created out of income)		6,10,901.56	3,22,796.80	—	9,33,698.36	—	—	9,33,698.36
14.	Mini Bus maintenance Fund (created out of income)		10,187.79	—	—	10,187.79	6,776.90	3,410.89	—
15.	Library Fund (created out of income)		5,825.59	—	—	5,825.59	3,479.00	2,346.59	—
16.	Donation from Seth Purshottamdas Thakordas & Divaliba Charitable Trust for the "The R. G. Saraiya Research Grant"		25,000.00	—	—	25,000.00	—	—	25,000.00
17.	Specific Donation from Darbar Alkachar Charitable Trust for Seminar Expenses		5,000.00	—	—	5,000.00	5,000.00	—	—
18.	Fixed Assets Fund		1,33,310.96	‡9,602.50	—	1,42,913.46	34,479.35	—	1,08,434.11
19.	Building Fund		1,03,227.68	—	11,000.00	1,14,227.68	11,000.00	—	1,03,227.68
20.	General Reserve Fund		37,952.71	‡1,69,671.31	—	2,07,624.02	—	—	2,07,624.02
21.	Provision for Depreciation on Investment		9,266.10	—	—	9,266.10	—	9,266.10	—
22.	Provision for Capital Losses		15,025.23	—	—	15,025.23	—	15,025.23	—
23.	Centenary Celebration Fund		89,340.39	—	—	89,340.39	—	89,340.39	—
24.	Hornbill Newsletter Fund		50,000.00	—	5,500.00	55,500.00	5,500.00	50,000.00	—
25.	Publication Fund (BNHS)		8,84,317.36	—	—	8,84,317.36	—	—	8,84,317.36
	Carried over		24,50,790.20	5,04,486.13	1,40,159.08	30,95,435.41	1,31,418.98	1,79,273.81	27,84,742.62

No.	Name of the other Funds		Balance as per last Balance sheet 1	Amount recd./ appropriated during the year 2	Interest credited during the year 3	Total of columns 1 2 3 4	Expenditure on objects of the Society as shown in the Income & Expenditure A/c 5	Transferred to other funds during the year 6	Balance as on 31-12-87 7
	Brought over		24,50,790.20	5,04,486.13	1,40,159.08	30,95,435.41	1,31,418.98	1,79,273.81	27,84,742.62
26.	Govt. of India, Dept. of Science and Technology Publication Fund:								
	i) Sale Proceeds of Century of Natural History	3,422.77							
	ii) Sale Proceeds of Book of Indian Reptiles	10,818.04							
		14,240.81	1,12,189.40	14,240.81	—	1,26,430.21	—	—	1,26,430.21
27.	Staff Gratuity Fund		3,08,122.98	—	30,812.30	3,38,935.28	—	—	3,38,935.28
28.	Chacko Fund for Education and Conservation		—	59,400.00	—	59,400.00	11,840.30	—	47,559.70
29.	Dr Sâlim Ali Memorial Fund (including Rs. 1,00,000/- appropriation from Indira Gandhi Paryavaran Award as per Income & Expenditure Account)		—	1,21,250.91	—	1,21,250.91	—	—	1,21,250.91
	Total		28,71,102.58	6,99,377.85	1,70,971.38	37,41,451.81	‡1,43,259.28	1,79,273.81	34,18,918.72

NOTE: ‡

towards Library Book Binding	3,479.00
towards Depreciation on Fixed Assets	34,479.35
towards Property Expenses	11,000.00
towards Educational Objects including Hornbill Newsletter (Rs. 5,500/-)	94,300.93
	1,43,259.28

SCHEDULE 'C'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF THE BALANCE SHEET AS ON 31ST DECEMBER 1987

No.	*Name of the Grants*	*Unspent/over-spent balance as per last balance sheet* 1	*Amount received during the year* 2	*Unspent balance carried to next year* 3	*Income for the year as credited to Income & expenditure a/c.* 4	*Amount spent during the year* 5
1.	Grant Government of India, Ministry of Defence, Aeronautic Research & Development Board for ecological study of Bird Hazard at Indian Aerodromes	2,74,921.23	76,500.00	—	3,51,421.23	3,51,421.23
2.	Grant Government of India, Ministry of Defence, Aeronautic Research & Development Board for Bird Hazard Research Cell	—	1,16,614.00	78,938.75	37,675.25	37,675.25
3.	Grant Government of India, Ministry of Defence, Aeronautic Research & Development Board for Ecological Relevance of Whitebacked Vulture — The major bird strike hazard to Military Aircrafts in India	—	50,600.00	40,808.05	9,791.95	9,791.95
4.	*Grants from*: U.S. Department of Interior, Fish & Wildlife Service — National Park Service:					
	i) Study on the Movement & Population structure of Indian Avifauna	3,51,656.32	—	—	3,51,656.32	3,51,656.32
	ii) Hydrobiological (Ecological) Research Station at Keoladeo Ghana Sanctuary, Bharatpur	3,08,405.60	—	7,617.47	3,00,788.13	3,00,788.13
	iii) Study of Ecology of certain endangered species of wildlife and their habitats	2,54,894.60	—	—	2,54,894.60	2,54,894.60
	Carried over	11,89,877.75	2,43,714.00	1,27,364.27	13,06,227.48	13,06,227.48

No.	Name of the Grants	Unspent/over-spent balance as per last balance sheet 1	Amount received during the year 2	Unspent balance carried to next year 3	Income for the year as credited to Income & expenditure a/c. 4	Amount spent during the year 5
	Brought over	11,89,877.75	2,43,714.00	1,27,364.27	13,06,227.48	13,06,227.48
iv)	Study of Lesser Bustard (Florican) *Sypheotides indica* and the Bengal Florican *Eupoditis bengalensis*	2,18,477.10	3,62,723.00	1,40,510.85	4,40,689.25	4,40,689.25
v)	Ecology of Keoladeo National Park, Bharatpur	—	23,05,880.00	17,94,290.54	5,11,589.46	5,11,589.46
vi)	Ecology of Indian Elephant	—	14,11,862.00	13,10,065.11	1,01,796.89	1,01,796.89
vii)	The Ecology of Point Calimere Sanctuary (An Endangered Ecosystem)	—	9,10,279.00	8,66,186.27	44,092.73	44,092.73
viii)	Study of the Migration Pattern of Indian Birds and Avifauna Migration Study Data Bank	—	14,77,160.00	13,89,092.25	88,067.75	88,067.75
5.	Grant from Chief Wildlife Warden, Chandigarh, Punjab, for Bird Ringing Project at Harike	55,027.36	—	—	55,027.36	55,027.36
6.	Grant from Chief Wildlife Warden, Bhubaneshwar, Orissa, for Bird Ringing Project at Chilka	2,689.97	—	—	2,689.97	2,689.97
7.	Grant Govt. of India, Department of Environment, for the expenses on Secretarial Assistance to Dr Salim Ali for environment research programme for processing Archival material	3,753.38	30,197.00	21,453.38	12,497.00	12,497.00
8.	Grant Govt. of India, Dept. of Culture, for publishing the Centenary Seminar papers of the Society 1984-85 continued till 1987-88	29,657.45	—	29,657.45	—	—
	Carried over	14,99,483.11	67,41,815.00	56,78,620.12	25,62,677.89	25,62,677.89

No.	Name of the Grants	*Unspent/overspent balance as per last balance sheet* 1	*Amount received during the year* 2	*Unspent balance carried to next year* 3	*Income for the year as credited to Income & expenditure a/c.* 4	*Amount spent during the year* 5
	Brought over	14,99,483.11	67,41,815.00	56,78,620.12	25,62,677.89	25,62,677.89
9.	Grant Govt. of India, Dept. of Environment, for Airconditioning the Hornbill House Library and Collection rooms	8,14,150.00	—	8,14,150.00	—	—
10.	Grant Govt. of India, Dept. of Science and Technology for the publication of Centenary Supplement Issue of Journal during 1987-88	—	50,000.00	—	50,000.00	50,000.00
11.	Grant Indian National Science Academy for the publication Journal 1987-88	—	5,000.00	—	5,000.00	5,000.00
12.	Grant from Chief Wildlife Warden, Jammu & Kashmir for the Project on survey of Blacknecked Crane	83,027.45	—	44,292.29	38,735.16	38,735.16
13.	Grant Govt. of Maharashtra for building repairs for 1984-85 contd. till 1987-88	1,08,662.76	—	74,514.76	34,148.00	34,148.00
	Total	25,05,323.22	67,96,815.00	66,11,577.17	26,90,561.05‡	26,90,561.05

NOTE: ‡

towards Property Repairs	34,148.00
towards Journal Printing (Educational)	55,000.00
towards Other Educational Activities	26,01,413.05
	26,90,561.05

SCHEDULE 'D'

BOMBAY NATURAL HISTORY SOCIETY

SCHEDULE FORMING PART OF BALANCE SHEET AS AT 31ST DECEMBER 1987

CASH AND BANK BALANCES

A) *In Current Account with:*		
i) Grindlays Bank Plc, M G Road, Bombay 400 023	1,29,817.26	
ii) Grindlays Bank Plc, London (Pnd. 3,084.31)	70,939.13	
iii) Standard Chartered Bank, M G Road, Bombay 400 023	84,353.15	2,85,109.54
In Savings Account with:		
iv) Grindlays Bank Plc, M G Road, Bombay 400 023	8.84,889.73	
v) Bank of India Museum Savings Br., Bombay 400 023	1,32,697.33	
vi) Bank of Baroda, University Br., M G Road, Bombay 400 023	5,07,011.96	
vii) Corporation Bank, Dalal Street Br., Bombay 400 023	32,04,039.71	
viii) Grindlays Bank Plc, M G Road, Bombay 23 for Salim Ali Memorial Fund	21,288.87	47,49,927.60
B) *Fixed Dposit with:*		
i) Bank of India, M G Road, Bombay 400 023	1,19,583.34	
ii) Standard Chartered Bank, M G Road, Bombay 400 023	1,00,000.00	
iii) Bank of Baroda, University Br., M G Road, Bombay 400 023	1,00,000.00	
iv) Corporation Bank, Dalal Street, Bombay 400 023	6,00,000.00	
v) Grindlays Bank Plc, M G Road, Bombay 400 023	1,55,000.00	
C) *In Monthly Income Certificate with:* Bank of India, M G Road, Bombay 400 023	7,75,000.00	18,49,583.34
	Total Rs.	68,84,620.48

Regd. No. F-244 (BOM)

BOMBAY NATURAL HISTORY SOCIETY

BOMBAY PUBLIC TRUSTS ACT 1950
SCHEDULE IX VIDE RULE 17(1)
THE BOMBAY NATURAL HISTORY SOCIETY, BOMBAY 23

INCOME & EXPENDITURE ACCOUNT FOR THE YEAR ENDED 31ST DECEMBER 1987

EXPENDITURE		
To *Expenses in respect of properties*:		
Rates & Taxes	4,826.00	
Insurance (on Building)	266.00	
,, *Other Contingency Expenses*: Contingency expenses, Electricity charges, etc. including Rs. 11,000/- charged to Building Fund (as per contra)	23,558.25	
,, *Repairs and Maintenance*: Met out of grant Govt. of Maharashtra for 1984-85 contd. till 1987-88	34,148.00	62,798.25
,, *Establishment Expenses*:		
A) Salaries including D.A. etc. for Reference Collection Staff for the period		
i) 1-1-87 to 31-3-87	42,425.55	
ii) 1-4-87 to 31-12-87	1,59,495.50	
Carried over	2,01,921.05	62,798.25

INCOME		
By *Rent*		
,, *Interest* (Accured):		
On securties	110.00	
On Fixed Deposits and Bank Account (including Rs. 190971.38 on earmarked funds)	3,36,956.61	3,37,066.61
,, *Dividend*		
(On Units of Unit Trust of India under reinvestment plan)		47,749.00
,, *Donation* (In cash or kind)		
i) General Donation	6,947.72	
For Hornbill Newsletter from Mehta Scientific Trust	11,000.00	
Carried over	17,947.72	3,84,815.61

Expenditure		
Brought over		62,798.25
To *Establishment Expenses* (Contd.)	2,01,921.05	
B) Salaries including D.A. etc. other than above including Rs. 15,184.55 for Plant Study Staff	6,14,940.56	
Wages	5,335.00	
Medical Expenses to staff members	9,300.00	
Leave Travel Expenses to Staff Members	2,562.60	
Society's Contribution to Staff Provident Fund	17,893.00	
Postage	23,317.75	
Printing & Stationary	42,481.10	
Advertisement	1,250.00	
Telephone Rental & Call charges	10,577.75	
Meeting Expenses	8,608.55	
Conveyance & Travelling expenses	5,268.15	
Bank Charges	3,264.83	9,46,720.34
To *Audit Fees*:		1,000.00
„ *Amount Written off* Irrecoverable dues		30,388.05
„ *Miscellaneous Expenses*:		
General Contingency Expenses	11,683.90	
Insurance Premium for Fire & Accident	4,719.00	
Repairs to Furniture & Equipment	7,627.00	
Garden Maintenance expenses	900.00	
Professional Fees	750.00	
Travelling expenses for attending Executive Committee Meetings (to Executive Committee Members)	2,000.00	27,679.90
Carried over		10,68,586.54

Income		
Brought over		3,84,815.61
By *Donations* (Contd.)	17,947.72	
ii) For Specific Donation Charles McCann Vertebrate Zoology Field Work Fund	1,895.52	
Plant Study Fund	20.00	
Staff Welfare Fund	500.00	
Fixed Assets Fund	9,602.50	
Salim Ali Memorial Fund	21,250.91	
Chacko Fund for Education and Conservation	59,400.00	1,10,616.65
iii) Life Membership contribution Individuals		2,32,045.59
„ *Grants*		
Grant Govt. of Maharashtra Bldg. Maintenance and 1986-87 for Establishment, Bldg. Maintenance and Educational Activities (Journal Printing) (including Rs. 28,714.00 for Nature Study Teaching Scheme)		2,13,266.00
„ *Other Grants as per Schedule 'C'*		26,90,561.05
„ *Income from Subscriptions and Entrance Fees*:		
Membership Subscription (Individual)	1,82,657.96	
Students Membership Subscription	4,180.00	
Corporate Membership Subscription	26,667.34	
Subscription to Journal (Non-Members)	42,152.83	
Entrance Fees	42,445.00	2,98,103.13
„ *Income from Publications*:		
Journal Sales	1,003.00	
Carried over	1,003.00	39,29,408.03

EXPENDITURE

Brought over			10,68,586.54
To *Depreciation*:			
On Furniture & Equipment		13,522.10	
On Motor Cars, Motor Cycle, Mini Bus and Auto Cycle (met out of Fixed Assets Fund as per Schedule 'B')		20,957.25	34,479.35
„ *Amount Transferred to Reserve or Specific Funds*:			
i) Life Membership Fund Contribution received during the year		2,32,045.59	
ii) *Other Funds*: Specific Donations transferred to respective account		92,668.93	
iii) Interest on earmarked investments/deposits		1,90,971.38	
iv) Sale Proceeds of Publications (Govt. Publication Fund)			
a) Century of Natural History	Rs. 3,422.77		
b) Book of Indian Reptiles	Rs. 10,818.04	14,240.81	
v) Grant Govt. of Maharashtra for Nature Study Teaching Scheme for 1986-87 transferred to Receipts & Payment account of Nature Education Scheme		28,714.00	5,58,640.71
Carried over			16,61,706.60

INCOME

Brought over		39,29,408.03
By *Income from Publication* (Contd.):	1,003.00	
Book of Indian Birds	25,548.19	
Book of Indian Animals	28,934.00	
Some Beautiful Indian Trees	3,701.00	
Some Beautiful Indian Climbers & Shrubs	3,780.10	
Identification of Poisonous Snake Charts	142.15	
Synopsis of the Birds of India & Pakistan	1,460.00	
Grasses of Western India	558.00	
Hornbill Stickers	342.00	
Book of Indian Reptiles	10,818.04	
Century of Natural History	3,422.77	
Nature Calendars	1,12,805.85	
Greeting Cards	3,22,796.80	
Other Publications	5,263.79	
Surplus on Packing and Forwarding	977.33	5,21,553.02
„ *Miscellaneous Income*:		
Mrs Indira Gandhi Paryavaran Award from Department of Environment, Govt. of India	1,00,000.00	
Miscellaneous receipts (General)	1,359.28	
Carried over	1,01,359.28	44,50,961.05

EXPENDITURE		
Brought over		16,61,706.60
To *Appropriations to Specific Funds*:		
i) *Education & Research Funds*: Surplus from Greeting Cards	3,22,796.80	
ii) Salim Ali Memorial Fund: Indira Gandhi Paryavaran Award	1,00,000.00	4,22,796.80
,, *Expenses on Objects of the Trust*:		
i) Educational: Met from respective Fund as per Schedule ‘B’	88,800.93	
ii) Expenses met out of grants as per Schedule ‘C’	26,01,413.05	
iii) For Publishing the Journal of the Society:		
a) Centenary Supplement Issue (including Rs. 50,000/- from D.S.T. Govt. of India grant)	1,03,535.90	
b) Regular Journals of the Society (including Rs. 5,000/- from Indian National Science Academy)	1,67,149.80	
iv) For Publishing Hornbill Newsletter including Rs. 11,000/- from Mehta Scientific Trust and Rs. 5,500/- from Hornbill Newsletter Fund	52,214.60	
Carried over	30,13,114.28	20,84,503.40

INCOME		
Brought over		44,50,961.05
By *Miscellaneous Income* (Contd.):	1,01,359.28	
Surplus on Nature Camps	39,376.04	
Exchange Fluctuation (Grindlays Bank A/c. London)	11,400.78	
Fees for the use of Society’s transparencies	12,500.00	
Royalty on Dr Salim Ali’s Publications	44,632.62	2,09,268.72
,, *Administrative Fees*:		
For handling Greeting Cards Sales Account	44,017.75	
For handling Century of Natural History Publication sales	844.65	
For handling Book of Indian Reptiles Publication sales	2,534.91	
For handling Project Funds	2,90,539.75	
For handling other earmarked Funds	12,895.23	3,50,832.29
By *Amount Transferred from Specific Funds*:		
From Building fund towards expenditure on Building maintenance	11,000.00	
From Hornbill Newsletter Fund towards expenditure on Hornbill Newsletter Publication	5,500.00	
Carried over	16,500.00	50,11,062.06

Expenditure			Income		
Brought over		20,84,503.40	Brought over		50,11,062.06
To *Expenses on Objects of the Trust* (Contd.):	30,13,114.28		By *Amount Transferred from* (Contd.):	16,500.00	
To *Library Account*:			From Fixed Assets Funds towards depreciation (per contra)	34,479.35	
Subscription to other Societies	12,659.88		From various specific funds towards expenses on objects of the trusts as per schedule	92,279.93	1,43,259.28
Purchase of Books	4,254.41				
Book binding expenses (met out of Library Fund, as per Schedule 'B'	3,479.00	30,33,507.57			
,, *Field Study Programme and Other Field Study Expenses and Members Activity*	10,798.30				
,, *Stamp Exhibition Expenses*	1,980.00	12,778.30			
To *Maintenance of Reference Collection*:		5,212.45			
Excess of Income Over Expenditure transferred to Balance Sheet		18,319.62			
Total		51,54,321.34	Total		51,54,321.34

Honorary Treasurer,
Bombay Natural History Society

Honorary Secretary,
Bombay Natural History Society

As per our report of even date
HABIB & CO.,
Chartered Accountants

TRUSTEE
Bombay, 16th September 1988.

BOMBAY NATURAL HISTORY SOCIETY
NATURE EDUCATION SCHEME
RECEIPTS & PAYMENTS ACCOUNTS FOR THE YEAR ENDED 31ST DECEMBER 1987

	RECEIPTS				PAYMENTS		
Bo	*Balance as on 1st January 1987:*			By	*Refund of advance to*		
	1. With Grindlays Bank Plc	6,734.51			*Bombay Natural History Society*		26,860.37
	2. With Nature Education Organiser	200.00	6,934.51	,,	Salaries (Nature Education Organiser)		31,353.95
,,	*Grants:*			,,	Printing & Stationery a/c.		1,542.00
	Govt. of Maharashtra for the year 1986-87		28,714.00	,,	General charges a/c.		3,111.45
,,	*Sale of Nature Study Booklets:*		290.75	,,	Postage a/c.		518.05
				,,	*Balance as at 31st December 1987*		
,,	*Advance from Bombay Natural History Society*		27,855.62		1. With Grindlays Bank Plc	209.06	
					2. With Nature Education Organiser	200.00	409.06
	Total		63,794.88				63,794.88

Honorary Treasurer, Bombay Natural History Society	*Honorary Secretary,* Bombay Natural History Society	As per our report of even date HABIB & CO., *Chartered Accountants*

TRUSTEE
Bombay, 16th September 1988.

THE SOCIETY'S PUBLICATIONS

The Book of Indian Animals, by S. H. Prater, 4th edition (reprint). 28 plates in colour by Paul Barruel and many other monochrome illustrations. (*Price to members Rs.* 70)

The Ecology of the Lesser Bandicoot Rat in Calcutta, by James Juan Spillett. Rs. 10

The Book of Indian Birds, by Sálim Ali. 11th (revised) edition. 74 coloured and many monochrome plates. (*Price to members Rs.* 75)

A Pictorial Guide to the Birds of the Indian Subcontinent, by Sálim Ali & S. Dillon Ripley (*in press*)

A Synopsis of the Birds of India and Pakistan, by S. Dillon Ripley II. An up-to-date checklist of all the birds resident and migrant, including those of Nepal, Bhutan, Bangladesh and Sri Lanka. 2nd edition. (*Price to members Rs.* 80)

Checklist of the Birds of Maharashtra, by Humayun Abdulali, 2nd edition. Rs. 4

Checklist of the Birds of Delhi, Agra and Bharatpur, by Humayun Abdulali & J. D. Panday. Rs. 3.00

The Book of Indian Reptiles, by J. C. Daniel (*Price to members Rs.* 85)

Identification of Poisonous Snakes, Wall chart in Gujarati, and Marathi. Rs. 5

Some Beautiful Indian Trees, by Blatter and Millard. With many coloured and monochrome plates. 3rd edition (Reprint). (*Price to members Rs.* 35)

Some Beautiful Indian Climbers and Shrubs, by Bor and Raizada. With many coloured and monochrome plates. 2nd edition. (*Price to members Rs.* 85)

Grasses of Western India, by Toby & Patricia Hodd. With 64 monochrome plates. (*Price to members Rs.* 37.50)

Encyclopedia of Indian Natural History, Edited by R. E. Hawkins (*Price to members Rs.* 215)

A Century of Natural History, Edited by J. C. Daniel (*Price to members Rs.* 145)

Glimpses of Nature Series Booklets:

1. OUR BIRDS I (with 8 coloured plates) in Kannada Rs. 0.65
2. OUR MONSOON PLANTS (with 8 coloured plates) in Hindi and Marathi. Rs. 0.80
3. OUR ANIMALS (with 8 coloured plates) in Gujarati, and Hindi. Rs. 1.25

TERMS OF MEMBERSHIP

Entrance Fees:	
Ordinary and Life Members	Rs. 50
Student Members	Rs. 10
Subscription:	
(*a*) Ordinary individual Members	Rs. 75
(*b*) Ordinary Corporate Members	Rs. 250
(*c*) Ordinary Members resident outside India	Rs. 350
Life Members	Rs. 2000 (Rs. 250 after 20 years)
Life members resident outside India	Rs. 5000
Student Members (without Journal)	Rs. 25
Annual subscription to Journal	Rs. 270

Members residing outside India should pay their subscription by means of orders on their Bankers to pay the amount of the subscription to the Society in Bombay on the 1st January in each year. If this cannot be done, then the sum of £15 should be paid annually to the Society's London Bankers—The Grindlays Bank Ltd., 13, St. James's Sq., London SW1Y 4LF. Account No. 1101091.

The subscription of members elected in October, November, and December covers the period from the date of their election to the end of the following year.

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